SAE Journal

AUGUST 1956

IN THIS ISSUE . . .

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Published by The Society of Automotive Engineers

More than half* of the

10,720,782

passenger cars produced in the U.S. from January 1, through

June 2, 1956 were equipped with

PERFECT CIRCLE
Type "98" Chrome Oil Rings

*
52.6% were Perfect Circle's new Type "98" Chrome oil rings. 47.4% were all other oil ring types combined, including other Perfect Circle oil ring types.

FACTS

about

NEW DEPARTURE
BALL BEARINGS

Split Inner Ring Main Shaft Ball Bearing

FOR AIRCRAFT TURBINES

High speeds, high temperatures and heavy loads . . . both radial and thrust . . . characterize bearing applications for turbines used in present ultra-fast aircraft.

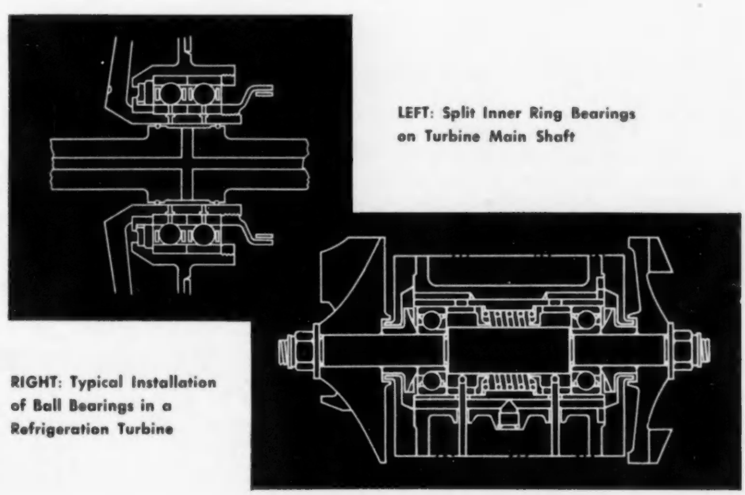
New Departure's Aircraft Bearing Research Program has produced ball bearings for highly satisfactory operation in small, medium and large turbines and their accessories.

Under this program, ball bearings of different steels dimensionally stabilized for high-temperature operation have been developed and produced. Needs for bearings with high-thrust capacity and varied lubricating methods have been met. And, bearings with various geometrical specialities to satisfy difficult mounting and operational requirements were designed.

Beyond this, New Departure is working on bearing developments for the more powerful, faster aircraft of tomorrow.

For further details, send for Folder TB, on turbine bearings.


Accessory Ball Bearings


LEFT: Split Inner Ring Bearings on Turbine Main Shaft

RIGHT: Typical Installation of Ball Bearings in a Refrigeration Turbine

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

if your professional interest is in **missile development,**
you belong at Martin-Denver

For when you combine the challenging problems in our project of conquering outer space with the advantages of living in the colorful Rocky Mountain area . . . you will have the ultimate in realizing your professional aspirations.

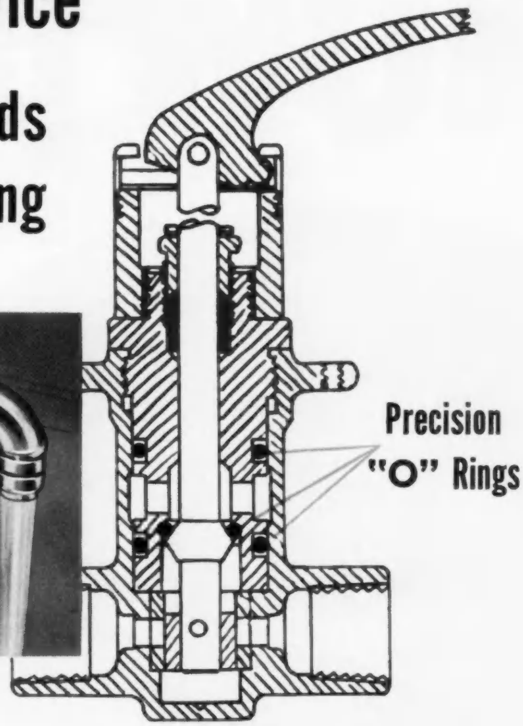
The Martin Company invites you to TAKE ANOTHER LOOK at the real engineering opportunities in Denver, Colorado and *write to Emmett E. Hearn, Empl. Director, P. O. Box 179, Dept. E-6, Denver 1, Colorado*

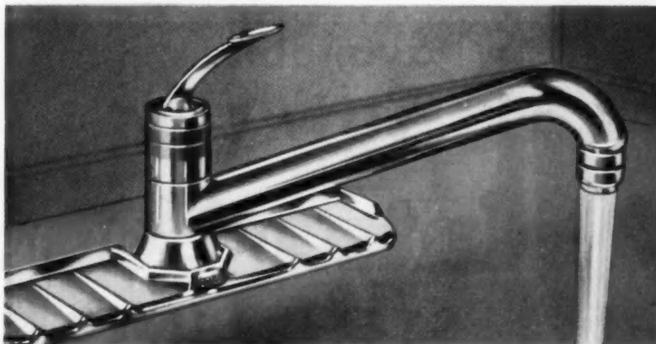
MARTIN
DENVER DIVISION

SAE JOURNAL, August, 1956, Vol. 64. No. 9. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948, at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.

New Faucet with Precision "O" Rings gives longer service

...ends dripping



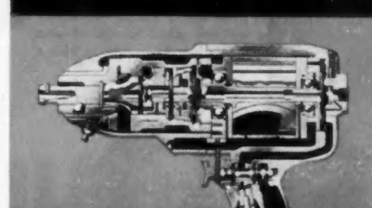


The Gyro Brass Manufacturing Corporation water faucet has no washers, spindles or seats to replace or renew. With the aid of Precision "O" Rings, a single motion controls both water volume and temperature. Dripping is eliminated. Endurance tests indicate ring life of over 15 years of normal service.

For Gyro Brass Manufacturing Corporation, and for hundreds of other manufacturers, the use of Precision "O" Rings means dependable long life service. They are compression molded—rigidly inspected—meet all military and commercial specifications—the finest made! At Precision, you'll find "O" rings in sizes and compounds to meet your requirements.

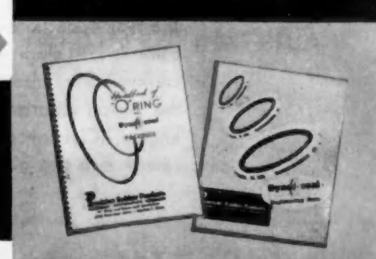
What is your sealing problem? There is an expert—the Precision engineer—ready to help you in product design and "O" ring specifications. You can rely on him—and on Precision, the world's largest exclusive producer of "O" Rings.

Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.



In air-powered impact wrench, 14 floating "O" rings help achieve compactness, result in reduced break-out friction and lower running friction.

Write for your free copies of Precision catalogs on "O" Rings and Dyna-seals



Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

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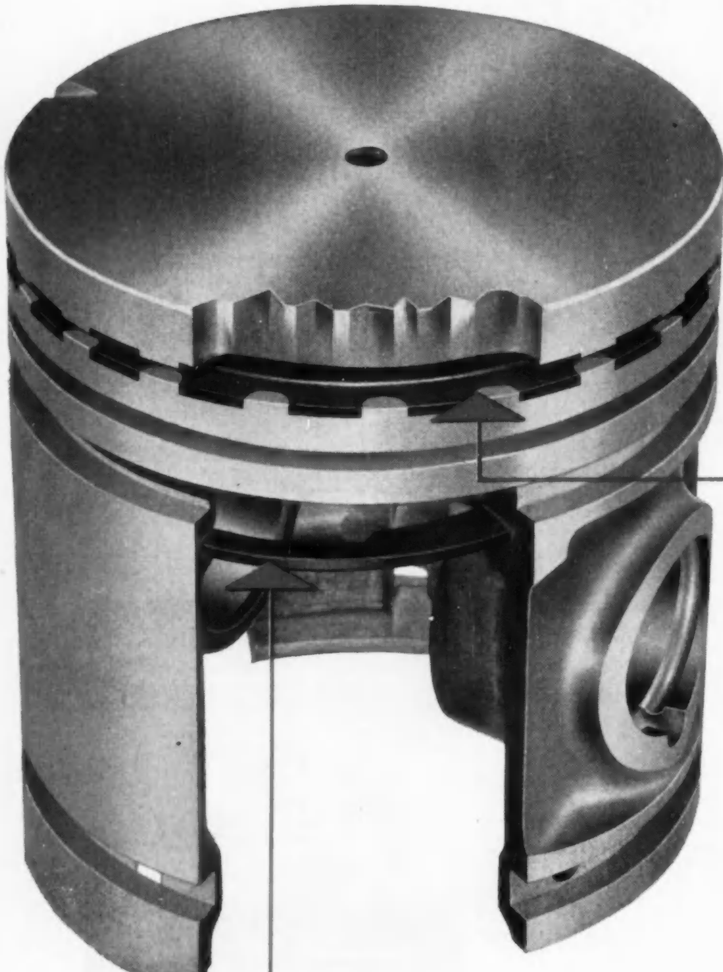
Canadian Plant at: Ste. Thérèse de Blainville, Québec

NOW! STERLING CONFORMATIC* PISTONS



are available with LOW COST

Intra-Cast* STEEL-LINED GROOVES

***Steel protection—top and bottom*—gives sensationally longer life to rings and grooves.**

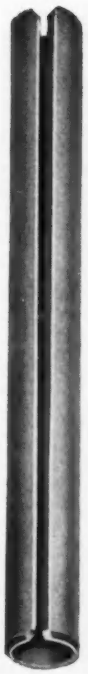
This ring is *integrally cast* into the piston . . . positioned so that when the grooves are machined, the top ring groove is *lined with steel* and has islands of aluminum for ring cooling. This Intra-Cast steel-protected groove resists enlargement and materially reduces top ring land wear and rounding. And, it does it at far less cost than other methods.

CONFORMATIC STEEL CONTROL MEMBER, anchored at the pin bosses only, controls skirt clearance . . . hot or cold! The metered steel insert allows you to specify the piston clearance *you* want for your engine. (Clearances from zero to ½ thousandth inch are generally recommended.)

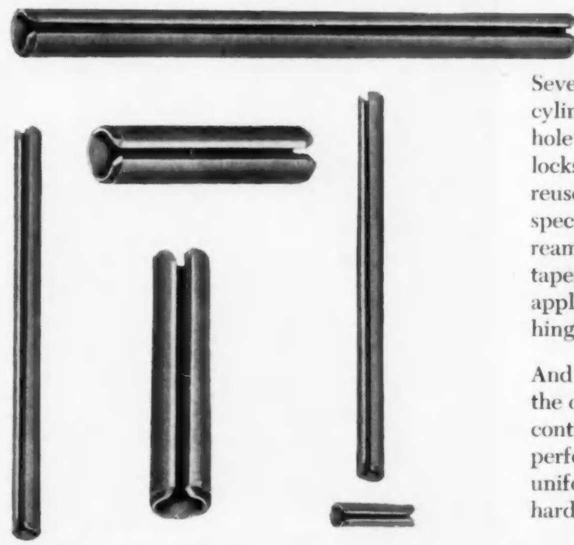
** Tradename Registered*

STERLING ALUMINUM PRODUCTS INC.

ST. LOUIS, MISSOURI



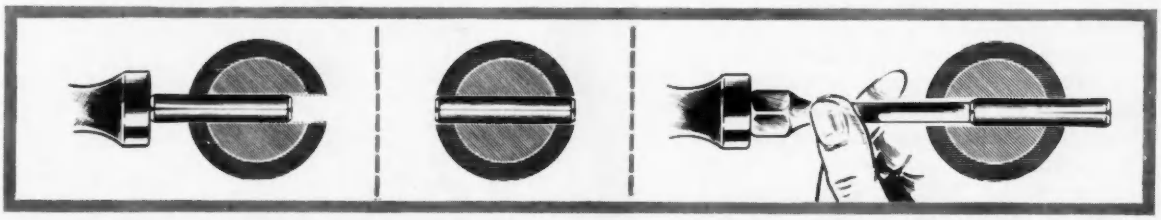
what makes this fastener DIFFERENT?



Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces.

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R40-875, 2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Rollpin Bulletin
☐ Elastic Stop nut Bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name ______ Title ______

Firm ______

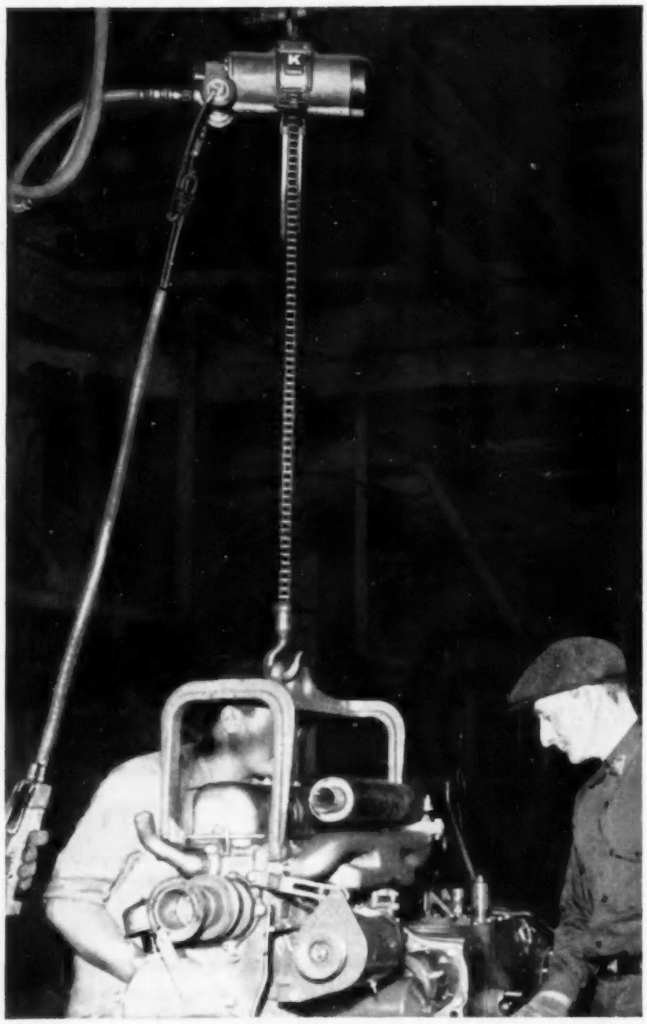
Street ______

City ______ Zone ______ State ______

Gardner-Denver... Serving the World's Basic Industries

Keep production on the up and up

with powerful, lightweight Keller Tool air hoists



Here's the hoist you can start and stop all day long—without any danger of a burned-out motor to halt production. It's powered by a Keller Tool axial piston air motor that just won't burn out.

Keller Tool air hoists offer other advantages as well, including easily controlled speed—fast for the high lift—creep for accurate load spotting.

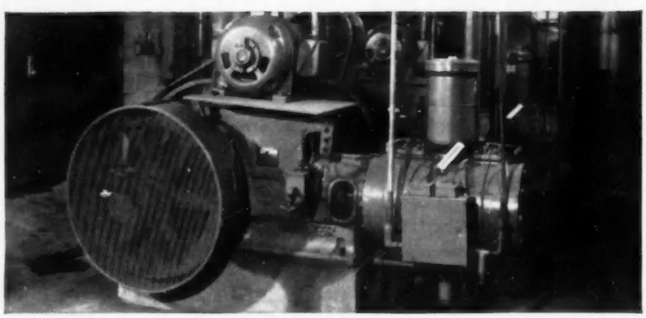
When you need a lift in a dusty room or in a corrosive atmosphere, a Keller hoist will handle the job without unusual maintenance. The enclosed air motor is made for such locations.

Every Keller Tool air hoist is light in weight in relation to its lifting capacity. Simplifies moving and hanging. All sizes furnished with roller chain; some sizes also available with link chain. Check the capacity you need in the table below:

Model	Capacity	Speed	Weight
86-1V3	300 lb.	80 f.p.m.	28 lb.
86-1V5A	500 lb.	35 f.p.m.	28 lb.
86-1V10*	1000 lb.	19 f.p.m.	28 lb.
86-2V10	1000 lb.	35 f.p.m.	78 lb.
86-2V20*	2000 lb.	19 f.p.m.	78 lb.

*Available with link or roller chain

Send today for Bulletin 86.



A popular unit in the compressor room: the Gardner-Denver RX. Capacities from 90 to 1300 cfm. Described in Bulletin HAC-40.

GARDNER-DENVER

KELLER TOOL division, Grand Haven, Michigan

THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

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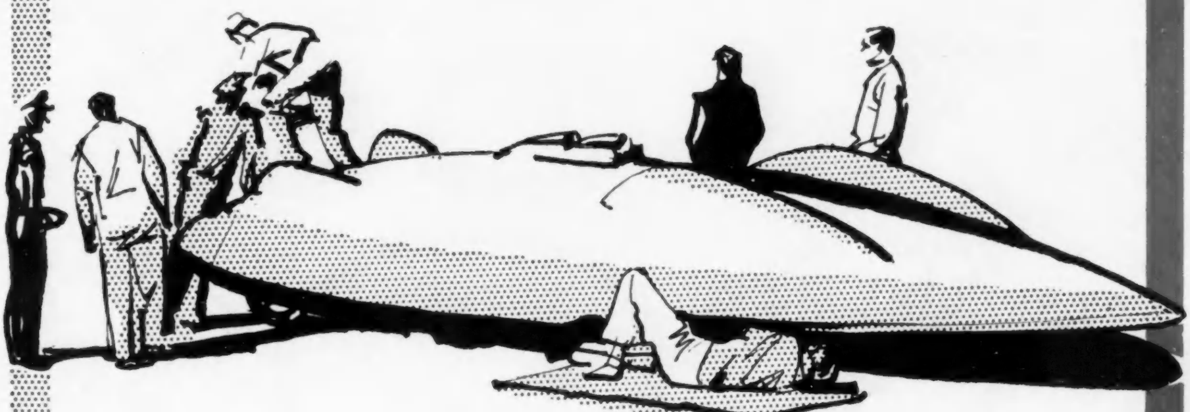
World Land Speed Record drivers Segrave, Campbell, Eyston and Cobb all relied on E.N.V. gears. Their records of success are tributes to the quality of E.N.V. products.



and World Markets

E.N.V. are manufacturers of all classes of bevel and hypoid gearing, helical and spur gearing, final drives and transmission units. They invite enquiries from companies in the United States of America wishing to develop the manufacture and sale of engineering products in Britain, Europe and the British Commonwealth.

Co-operation with E.N.V. brings the manufacturing resources of modern equipment comprised in two factories covering over a quarter of a million square feet, a capable and experienced labor force and the technical and general experience to gain access to new and expanding markets in many lands.

ENV

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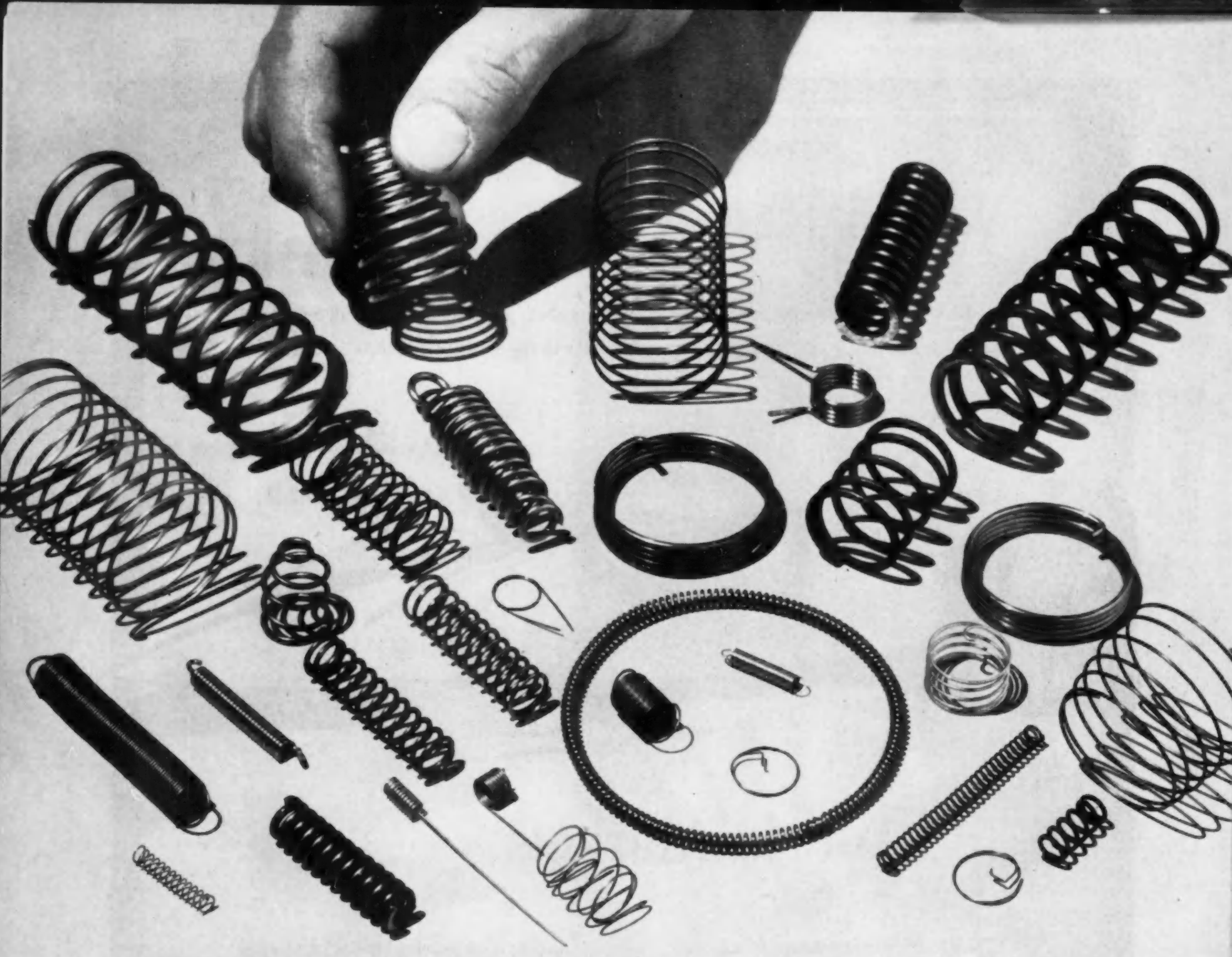


How the right "COAT" solves many spring problems

• Unless you yourself go in for forming wire springs, you have no idea what a tricky business it is. For one thing, as every fabricator knows, it takes extreme uniformity in the wire to obtain the precise dimensions and the exacting tension, torsion or compression characteristics so often required.

But uniformity alone won't always do the trick! As a leading supplier of special wire for tougher-than-usual spring requirements, National-Standard has delved deep into production problems and has come up with answers that help many a fabricator hold better to tough specifications and produce faster with less waste and more profit!

Time and again, for example, National-Standard has shown that merely a change in wire *coating* or lubrication quality is of major importance in forming operations. Proper coating also helps gain uniform dimensional response to heat treating. Quite often, in fact, troubles chalked up to wire variance are really the fault of improper coating or finish.

Helping fabricators solve problems and cut costs is a National-Standard specialty. We're geared for it and make a point of it. Try us and see!

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape

ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth

NS NATIONAL-STANDARD Company NILES, MICHIGAN

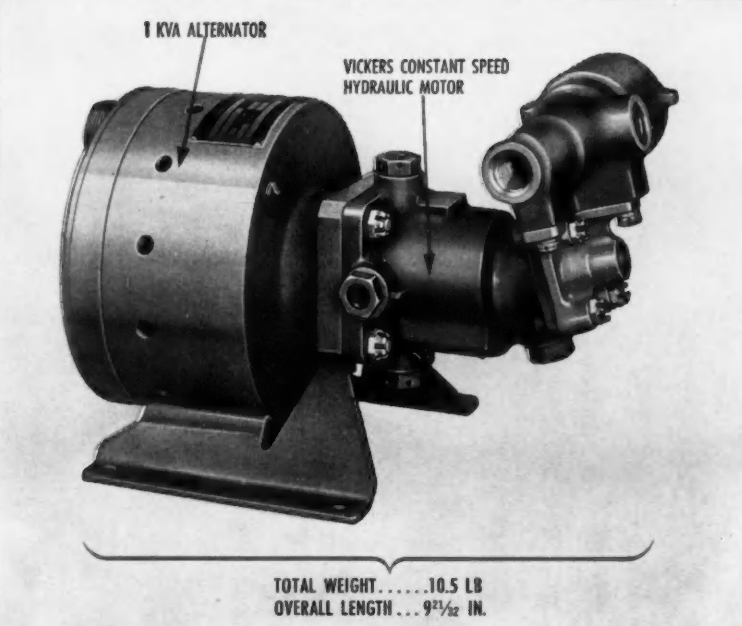
WAGNER LITHO MACHINERY • JERSEY CITY, N. J.
Special Machinery for Metal Decorating

WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

New Vickers Airborne Electrical Power Package

. . . Saves Weight and Space

Utilizes the Hydraulic System for More Efficient Production of AC Power



This new isolated electrical power package provides closely regulated AC power with minimum weight and envelope while drawing its power from a hydraulic system. In new designs or when adding electronic equipment to aircraft designs in which the electrical system is already loaded to capacity, this versatile package provides the needed AC power from flow available in the hydraulic system. This generally is permissible without system change as the full flow is seldom demanded except for a few seconds under rare circumstances. Even in such cases, full flow can be guaranteed to these hydraulic functions through the use of a simple priority valve which starves the AC power package momentarily.

Less Weight and More Efficient

Important weight savings are achieved through the use of this package instead of an inverter which may also require an increase in the DC generator and line capacities. In one instance, the 10.5 lb 1 kva package replaced a 38 lb inverter for co-pilot instrumentation. An additional advantage is that the package has 62% overall efficiency while that of the inverter was 35-40%.

Extreme altitude operation is no problem as the Vickers isolated electrical power package contains no brushes or other altitude-sensitive components.

Features of AC Generator

The permanent magnet type AC generator has excellent life and reliability. It requires no bulky voltage regulator . . . is inherently smaller and lighter than conventional generators due to the elimination of the exciter and slip rings. It also has higher overall efficiency resulting from elimination of all excitation losses. Additional advantages are that the permanent magnet is unaffected by momentary short circuit, or separation of field and armature without keeper, or by temperature cycling. It is also not susceptible to aging or shock. This unit is 120/208 volt, three phase, wye connected with 400 cps at 8000 rpm. It is capable of continuous duty under environments of 0-55,000 feet altitude and ambient temperatures from −65 F to 250 F.

Hydraulic Motor Drive

The generator is directly driven by a Vickers Constant Speed Hydraulic Motor having fixed stroke and an integral flow control valve that maintains an 8000 rpm speed setting within ±2½% regardless of the load (as long as valve inlet pressure is greater than load requirement). For the unit shown above, maximum operating pressure is 3000 psi while rated output of 1 kva requires operating pressure of 2200 psi. Special configurations will maintain 400 cps frequency within ±0.1% regardless of load. This motor has a very high horsepower-weight ratio and its overall efficiency exceeds 92%. It is a time-proved design capable of many hundreds of hours of continuous service without attention.

Many Uses and Sizes

The applications for this isolated power source are numerous. For multi-engine aircraft, its use for co-pilot instruments provides dual reliability. This package has been used to supply controlled frequency AC power in emergencies when the only source of power in the airplane is a ram air turbine driven pump. The efficiency of this arrangement minimizes the size and weight of the ram air turbine necessary to provide emergency hydraulic and electric power. *7492*

Now available in the sizes listed below, larger packages can also be supplied from existing components. Vickers is prepared to develop the package best suited to a specific need. For further information, write for bulletin A-5213 or get in touch with your nearest Vickers Aircraft Application Engineer.

Vickers Airborne Electrical Power Packages

kva output	weight, pounds
0.5	7.0
1.0	10.5
1.5	12.5
2.0	15
2.5	17
3.0	19

Larger capacities with minimum weight are available.

VICKERS INCORPORATED
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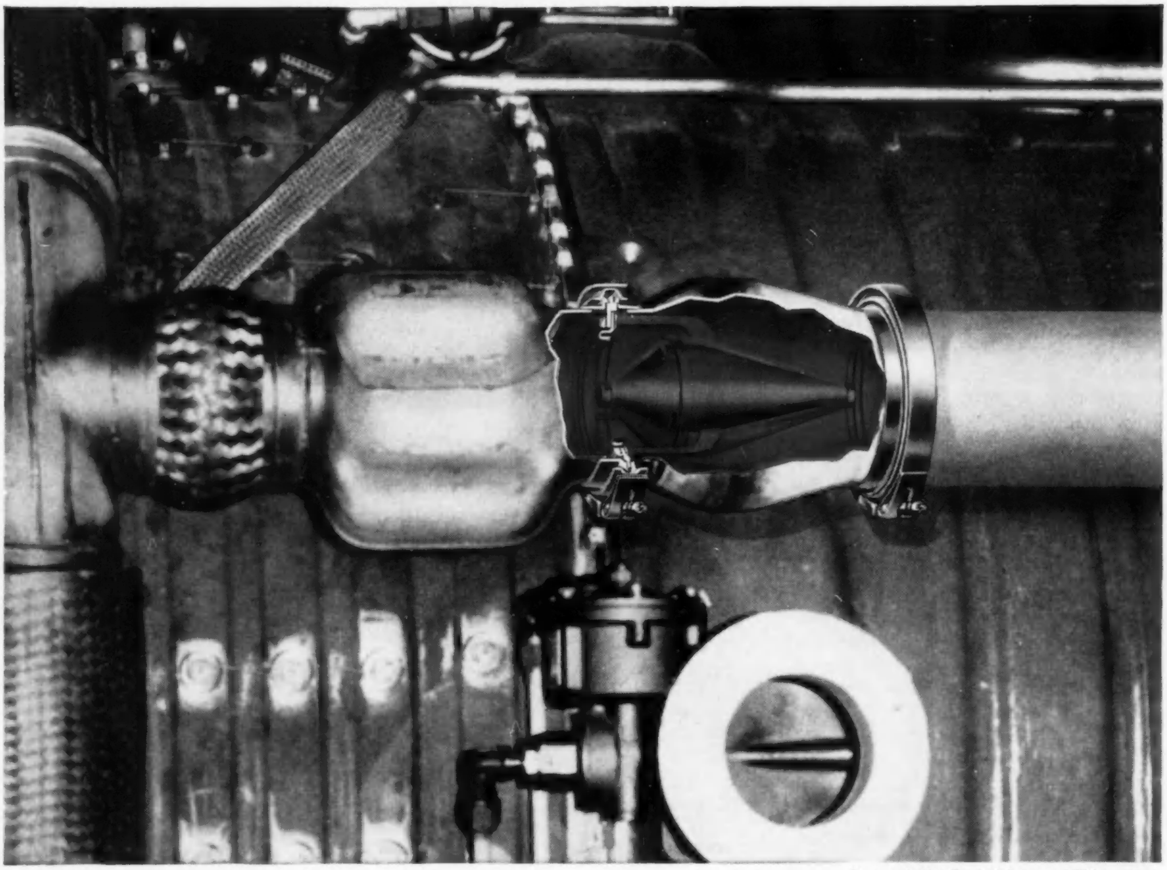


Marman In-Line Check Valve on a J-71 jet engine.

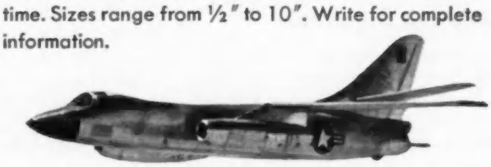
Solve Hot Bleed Air Problems with Marman Check Valves

NO FLUTTER regardless of air velocity . . . NO DISTORTION even at temperatures as hot as 1000° F. . . . FULL FLOW with minimum air resistance. These are the valve features that lead to positive control of hot air in jet engine bleed systems.

Marman In-Line Check Valves absorb severe reverse-flow shock without shattering, yet are sensitive enough to open fully even at low velocity and flow conditions. Operating pressure range is 28" vacuum to 300 psi.

Compact and smooth, with no external projections, Marman Check Valves are used effectively with the Marman J-11 Joint, which connects and disconnects quickly, reduces maintenance and downtime. Sizes range from ½" to 10". Write for complete information.

MARMAN CHECK VALVES ARE USED ON THE DOUGLAS RB-66



MARMAN PRODUCTS COMPANY, INC.

A SUBSIDIARY OF Aeroquip CORPORATION

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

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Oil seals are precision products. They are designed to operate under a specific set of conditions. Change just one of those conditions—lubricant, shaft speed, temperature, even bearing position—and a different seal will almost always be needed.

Why chance costly retooling or remanufacture? Specify the correct seal on the drawing-board. And when you do, get all the information there is on new seals, new lip compounds, and mechanical designs. Get it from your National Oil Seal Engineer. His counsel is complete, up-to-the-minute, and accurate. You couldn't buy better oil seal information, yet his help is yours for the asking.

Why "do it yourself?" Call the nearest National Oil Seal Engineer now.

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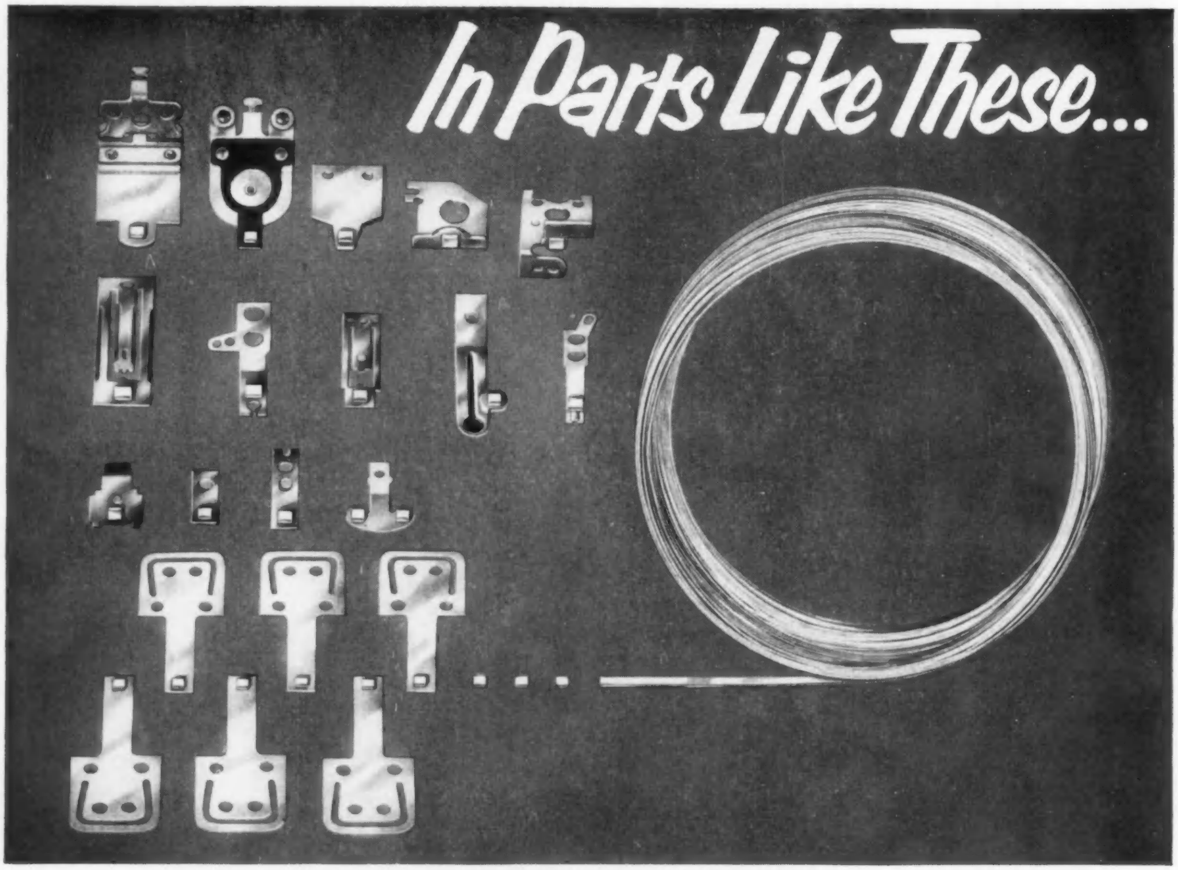

GENERAL PLATE...

Clad Electrical Contact Tapes

Reduce Costs, Minimize Assembly Operations, Permit Miniaturization and Improve Performance

Included among the many advantages offered by the use of General Plate Clad Electrical Contact Tapes are assembly accuracy, change-over ease, design freedom, *plus* immediate and substantial cost reductions, performance improvements, miniaturization and standardization.

Basically, electrical contact tape consists of an electrical contacting face of desirable composition and contour plus an elevated or serrated backing of readily electro-weldable material. The serrated back makes possible a larger weld area assuring much greater thermal and electrical conductivity from the contact to backing member assuring exceptional performance.

The contact face is available in practically any ductile contact material either as a single metal or clad to another metal. Contact backing or supporting materials are available in steel, brass, copper, phosphor bronze, beryllium copper, nickel or monel, and aluminum.

Why not find out how you can benefit with General Plate Clad Electrical Contact Tapes? Write for complete information, or better still, ask for a General Plate Engineer, who will gladly help you with your contact problems.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
1108 FOREST STREET, ATTLEBORO, MASSACHUSETTS

For the Sake of Argument

You Are a Magician . . .

By Norman G. Shidle

Everybody is a magician in his own right. Each of us keeps changing things into thoughts every day of his life. This is not only an ability we all have; it's a compulsion we can't avoid.

Those who may doubt the universality of this necromatic power need only pick an object and write down what it looks like, what it means, or what it is made of.

Two or more doubters should perform the experiment simultaneously. Then they need but compare what they write to see that each has changed the object into a slightly or wholly different thought.

Some folks change every minor event into a major crisis. Others change the same events into routine parades—in which they themselves feel no need to march.

. . . The saint changes persecutions into blessings; the sinner into alibis. Most of us do a little of both!

This constant, unconscious conjuring is, of course, the major barrier to accurate communication by anybody with anybody else. We start changing the things and ideas we hear long before we have "seen" them—even with our mind's eye.

In our magic-making, we tend to form habits, just as in our eating and shaving and commuting. Some turn almost everything into happy thoughts; others into fearful thoughts. Some turn the things they see into ideas for better things; others into criticism of what they think they see.

But however we use this power to turn things into thoughts, we all have it . . . and we all do it.

Eaton
Permanent Mold
Gray Iron Castings
Meet Critical Quality Requirements
in a Wide Range of Applications
In applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings provide a number of desirable characteristics:
Dense non-porous structure
Uniform structure throughout the casting
Machinability at higher feeds and speeds
Higher tensile strength
Ability to take high surface finishes
Freedom from leakage under pressure
These qualities particularly recommend Eaton Permanent Mold Gray Iron Castings for such uses as high pressure control mechanisms, refrigeration and air conditioning parts, power steering and power braking components, household appliance parts, and for many other critical applications.
Eaton engineers will be glad to discuss the application of Eaton Permanent Mold Gray Iron Castings to your products.
EATON
FOUNDRY DIVISION
MANUFACTURING COMPANY
VASSAR, MICHIGAN

SAE
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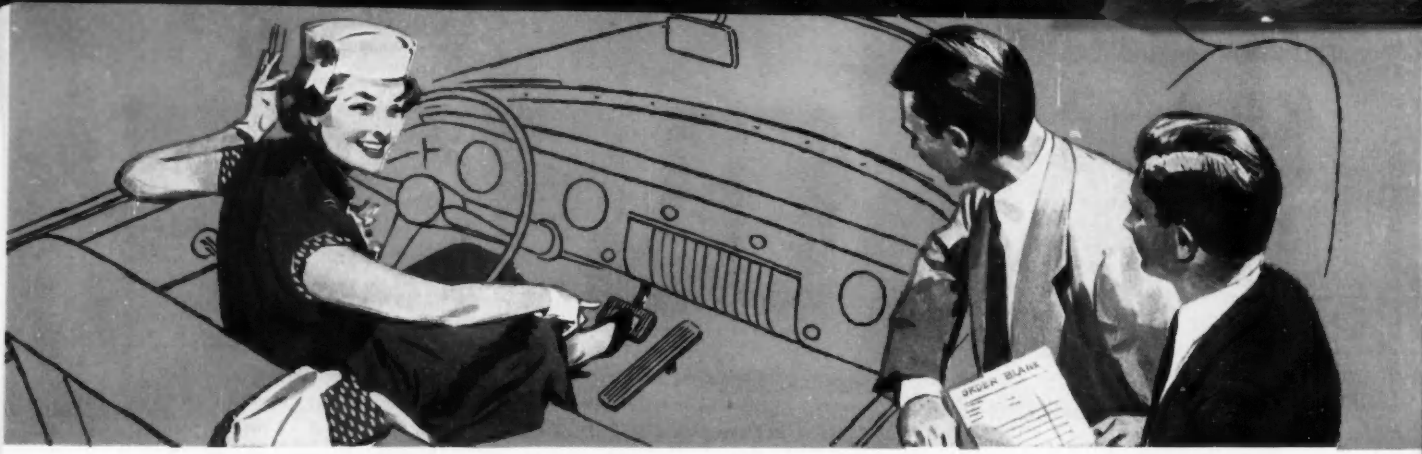

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Engineering

100 Years from NOW

A. A. Kucher, Ford Motor Co.

Excerpts from talk presented before SAE Council at its June 7, 1956, meeting in Atlantic City.

NUMEROUS guideposts exist which point the way for reasonable assumptions for extrapolating engineering progress in industry between 1956 and 2056.

For one thing, the future demands of each of us an increasing respect and regard and recognition of the abilities of others . . . and thereby the full utilization of convergent knowledge through collaboration and cooperation.

Each of us can possess but a minute fraction of accumulated knowledge. So, we are increasingly dependent upon intimate association with others who possess related knowledge and ability. We are making progress, but much remains to be done to remove artificial barriers mainly generated by intolerance toward new concepts and a lingering resistance to change.

Many people resist change and innovation, not so much because they fear a new approach, but because to accept the new they must first give up the old.

A second area in which giant strides can be expected is that to be made by American industry in adapting automation on a truly broad basis. This will give enormous capability to produce more things better with less manual effort and less cost. A comparable parallel increase in the standard of living is, of course, inevitable. As an extra dividend, it is easy to predict that new opportunities and new things will be provided for our expanding population.

Beyond the realm of atomic energy, the harnessing of solar energy through photosynthesis already points the way to limitless supply of food and energy.

We are busy finding better ways of converting heat into mechanical energy. . . . We are developing new, high-strength, high-temperature, corrosion-resistant, low-cost materials for application to our present and future demands. . . . Such things as colored television, vertical ascension aircraft, supersonic flight, and earth satellites are mundane.

Let us assume that by the year 2056 man will require 28 times the present power input for a world population increased from the present 2.5 billion to 6 billion. . . . Next, assume that by employing all forms of available energy the needed supply of primary energy exists.

Of vastly greater economic significance than the means for producing the energy is the means of consuming the energy. . . . To approach the American standard of living other peoples must consume power at something like the rate we do—and that means using a lot of light bulbs, heaters, tractors, automobiles, and so forth.

The enormous problem confronting industrial engineering is:

1. To produce machines that produce the energy;
2. To produce the machines and devices to consume the energy.

How do we go about it?

Based on population growth alone, a quadrupling of technically trained people will be required. The demand already far exceeds the ability of the academic fraternity to provide. The solution requires the concerted efforts of the university, industry, and government.

Within the Next 100 Years . . .

. . . some of the things which appear feasible in the area of engineering progress include the possibilities listed below.

1. The future of materials will be limited largely to four metallic elements—iron, aluminum, magnesium, and titanium; and one semi-metal—silicon; for major construction.

The other elements are becoming scarcer and, therefore, too costly for use even as alloying agents. Copper, for example, is already more expensive than aluminum and may be re-

stricted to electrical uses only. The present position of titanium cost-wise is very likely to change in the future and may easily compete with stainless steel.

2. Materials for use in the 2000 to 3000 F range will undoubtedly be developed. Ceramics or ceramic metal compounds capable of standing rapid temperature changes will be commonplace. Metals in general will be produced to realize a bigger fraction of their theoretical strength. For example, the theoretical strength of present-day steels may be raised from 100,000 psi to about 1 million psi resulting in lighter and stronger structures.

3. Engineers will build in or remove dislocation and impurities so that the resulting material will have precisely the properties required. It will no longer be necessary to adapt systems to materials. On the contrary, the engineer will write a prescription for a material, hand it to the metallurgist, and he will compound the material in a fashion reminiscent of modern pharmacy.

4. By 2056, scientists will have long learned how to control the thermonuclear reaction. New furnaces will be available to the metallurgist—furnaces with temperatures in excess of 10 million degrees. By means of these new furnaces, scientists will be able to take a common material, for example, sand, and break it down into elementary entities and then resynthesize it into material of structural and electrical value.

5. Scientists will have learned about the ultimate particles in nature and with this knowledge will have learned how to utilize them.

6. Silicon, one of the most plentiful of materials, will be used as an electronic device to harness the free electrons. The efficiency of such devices will be increased to an extent that they will be widely used to convert solar energy into electrical energy, tapping an almost inexhaustible supply of energy.

7. One can conceive of cars run by electrical power generated by atomic reactors and propagated by microwave beams directed toward the car. The engine will consist of semi-conducting devices and motors of unusual design made of materials whose magnetic properties exceed those now known.

Man will no longer depend upon human response time and, therefore, all control functions will be electronic.

Industrial engineers will incorporate these response functions into sealed devices having complete dependability.

The degree of precision of mechanical devices will be expressed in angstroms rather than parts of an inch.

8. The quality of all products will have improved to a degree that those of us who are familiar with aircraft gadgetry can relax in complete tranquility.

Such things as miniature turbo machines to power vehicles, which we now look upon as a thing of the future, will be as commonplace in the not too distant future as the covered wagon was not many years ago.

9. Without doubt, individual transportation in the third dimension will compete with wheeled and wheelless ground vehicles.

10. As yet unrealized is the ideal polymer, resistant to heat, corrosion resistant, able to withstand useable loads far in excess of yield loads of present-day metallic materials. The ingredients of this polymer are yet to be found; however, there is good theoretical reason for believing that they will be found.

11. The age of the electronic brain is nearly, but not quite, upon us. Computing machines are still too cumbersome and expensive to be used for all but the most exacting, complicated, and indispensable tasks, yet one can already visualize electrical memory devices and information storage mechanisms requiring but a small volume, easily portable, and inexpensive.

12. Already the impetus for effecting a transformation in graphic records has been generated and research is underway for providing automatic electronic equipment for recording and storing information and, more importantly, for selectively searching and coordinating such information for broad ranges of complex subject matter. A further aspect of this research is the development of an apparatus for language translation. The engineer and scientist of the future will be able not only to dial into a machine for a bibliography of references on a subject of interest to him, but also to push a button and have a transcription presented to him.

Industrial chemistry will be developed to a point where a new chemical can be developed by feeding a set of specifications to a calculator and the required structure and synthesis will be promptly indicated by the machine. The products, whether they are plastic, glass, or other materials, will have unheard of strength and durability because the invisible flaws which now cause all materials to exhibit only a fraction of their theoretical strength will have long since been eliminated.

Voice writers and voice files will have been engineered into office use.

13. Steel, stone, wood, and other materials will be removed or cut by ultrasonic or electronic means at a rate and with a precision unheard of by present methods.

I believe that the historian of the future in evaluating the basic factors that have influenced human progress most will point to engineering during 1956 to 2056 and proclaim this century the golden years of engineering progress.

John Deere's 55H Self-Propelled Hillside Combine

. . . was designed for safety, stability, and durability on hillside ranching jobs.

Based on paper by **D. C. Heitshu,** John Deere Harvester Works

THE John Deere 55H Self Propelled Hillside Combine features:

- Automatic leveling
- Power steering to reduce operator fatigue
- Proper weight distribution for stability and safety
- Sturdy construction for safety and durability
- Good brakes for safe operation

Automatic leveling of the 55H combine is secured by using hydraulic power which is controlled by a hydrostatic head acting against a sensitive diaphragm. Movement of the diaphragm causes microswitches to make contact, energizing the proper solenoid for needed movement of the hydraulic valve which controls the flow of oil to and from the leveling cylinders. To speed up the hydrostatic action, a servo piston is placed in the reservoir and actuated by a swing arm.

This arrangement provides excellent automatic leveling control of the combine. For safety reasons, automatic check valves are installed on each leveling cylinder to guard against tipping the machine if hydraulic line or hose failure occurs.

The steering assembly of the 55H combine interchanges with the regular steering unit of the level land combine. The wheels are mounted on a parallelogram arrangement so that they remain vertical. This arrangement provides best steering and easiest control of the vehicle. The power steering installation is a conventional automotive hydraulic unit with drag link valve, and a booster cylinder receiving its power from a small pump mounted dual with the master hydraulic power pump.

Good weight distribution was achieved in the 55H combine by proper placement of the longitudinal center of gravity. Moving the drive wheels ahead of their level land position allowed a slight lengthening of the wheelbase, giving the desired center of gravity. No change was needed in lateral weight distribution.

The transmission and drive wheel assembly, along with the leveling cylinders, form a complete unit which interchanges with the conventional transmission and axle assembly used under the level land combine. In fact many of the parts in the hillside transmission are identical with those in the level land transmission. A planetary gear set is used in each drive wheel hub to reduce the torque imposed upon the universal joint drives from the differential to the drive wheels. Large disc brakes, mounted on each side of the differential, provide differential braking.

The John Deere 55H Self Propelled Hillside Combine uses the standard 55 separator, grain tank, and engine. For functional reasons the header swivel is located between the header platform and the feeder house. This enables the combine to have the regular feeding arrangement to the cylinder. This is a critical relationship for efficient performance.

A "low profile" tread tire is important for good hillside performance. In addition to being smooth, hillside tires must be large. On steep hills the soil is usually loose. To secure footing the tire must reach out and cover the maximum area because the soil shear value is low. Extra wide rims are used on the drive tires of the 55H combine. When 18-26 tires are used the rim is 20 in. wide. With 15-26 tires a 16 in. rim is used. On the 55H combine the 18-26 tire is the more popular because of its better all around performance.

A 9-16 smooth treaded tractor tire was found to give the best steering response under all conditions. This tire has the same "low profile" tread used on the drive tires. The 9-16 steering tires are mounted on 8 in. rims.

Paper "The Self Propelled Hillside Combine" on which this abridgment is based was presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, September 14, 1955 and is available in full from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.

Nomograph Aids

A CLEARER picture of engine and fuel behavior can now be obtained by plotting knock test results on a newly developed nomograph. With it we can easily study the effects of many engine variables on the ratings of sensitive fuels in passenger-car engines. These variables include compression ratio, engine speed, air density, distributor tolerances, and temperature.

The Method

The vertical line (A) shown in Fig. 1 will be used to represent any fuel rating obtained by the Research Method from 70 octane number at the low end to octane + 1.0 ml tel per gal at the high end. This line can, of course, be extended to include higher or lower values but the portion shown covers the current fuel quality range with some room to spare.

The octane-number scale used on this sheet is nonlinear. The authors have arbitrarily plotted fuel quality in proportion to AN performance numbers. Although it might have been possible to use a linear octane number scale, the scale shown is convenient because values above and below 100 are often involved.

The second laboratory quality control method often used by refineries is the Motor Method. This method is shown in Fig. 1 as a vertical line (B). The distance separating the Research Method line from the Motor Method line is unimportant. The octane-number lines are extended as horizontal lines across the sheet to include ratings obtained by the Motor

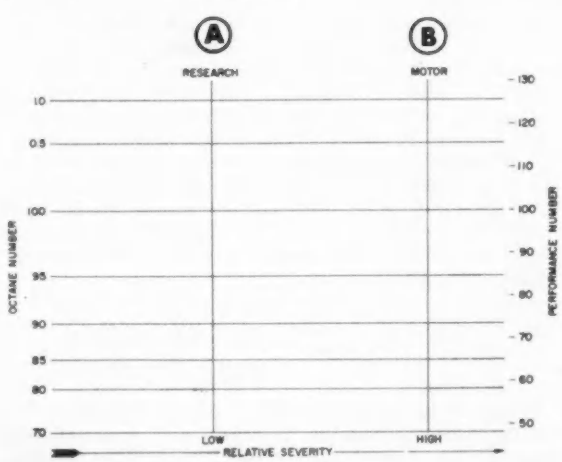


Fig. 1—Nomograph showing octane numbers plotted to AN performance-number scale.

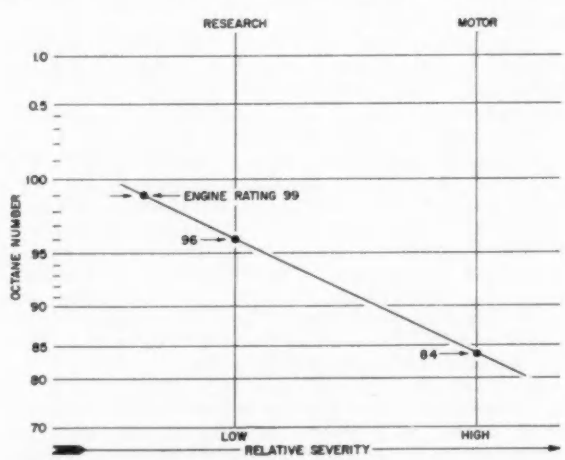


Fig. 2—Research and Motor Method ratings locate fuel sensitivity line.

Study of Knock

R. V. Kerley and K. W. Thurston, Ethyl Corp.

Excerpts from paper "Knocking Behavior of Fuels and Engines" presented at SAE Golden Anniversary Fuels & Lubricants Meeting, Philadelphia, Nov. 10, 1955. This paper will be published in full, with discussion, in the 1956 SAE Transactions.

Method. This is justified since these lines represent primary reference fuels and these are constant in all engines by definition. In other words, 80% octane in 20% heptane is always 80 octane number regardless of the engine or engine conditions used to make it knock.

The performance-number scale has been added along the right-hand margin for orientation. Across the bottom of the figure is the arbitrary phrase "relative severity." Most commercial fuels have a lower octane number when rated by the Motor Method than when rated by the Research Method, and the Motor Method is therefore said to be "more severe" than the Research Method.

If a fuel is rated by both methods this fuel may be represented by a line connecting the Motor Method rating value with the Research Method rating value. For convenience this line has been called a fuel sensitivity line. This is shown in Fig. 2. In this case the fuel had a rating of 84 octane number by the Motor Method and 96 octane number by the Research Method. The choice of a straight fuel sensitivity line is arbitrary but no serious disadvantages have been noted as a result of the assumption that all fuels can be represented by straight lines.

When this fuel is rated in any other engine the value obtained in the other engine can be represented by a point on the fuel line. For example, if a rating of 99 octane number is obtained in the third engine there is only one place where 99 octane number will intersect the fuel sensitivity line. This is

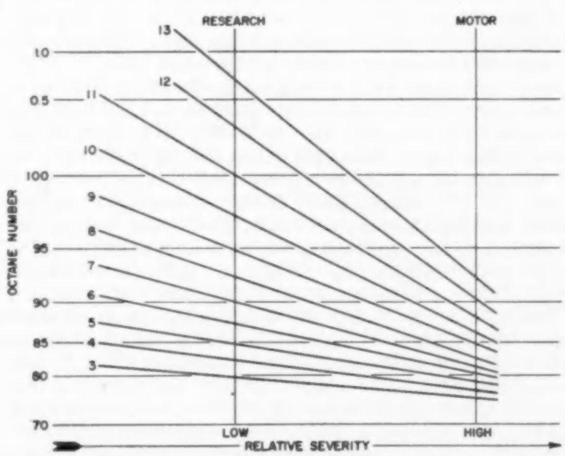


Fig. 3—Sensitive reference fuel series formed by blends of isooctane, normal heptane, and diisobutylene.

Table 1—"S" Reference Fuel Composition and Laboratory Ratings

Fuel	Composition % Diisobutylene	Composition % n-Heptane	Composition % Iso-octane	Octane Rating Motor Method	Octane Rating Research Method
1-S	15.3	35.0	49.7	72.9	75.0
2-S	22.9	36.4	40.7	74.4	77.5
3-S	32.2	38.0	29.8	76.0	80.0
4-S	36.2	36.7	27.1	77.2	82.5
5-S	38.9	34.5	26.6	78.7	85.0
6-S	41.8	32.2	26.0	80.0	87.5
7-S	44,9	29.7	25.4	81.4	90.0
8-S	46.1	26.5	27.4	82.9	92.5
9-S	43.6	21.9	34.5	85.0	95.0
10-S	40.8	16.9	42.3	86.6	97.5
11-S	37.9	11.6	50.5	88.3	100.0
12-S	34.9	5.9	59.2	90.4	110.0 PN
13-S	32.8	1.8	65.4	92.3	120.0 PN

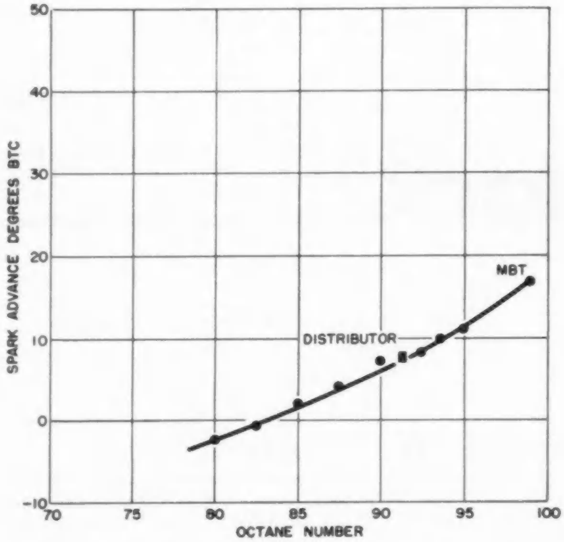


Fig. 4—Effect of spark advance on primary reference fuel requirement for engine make D at 1000 rpm.

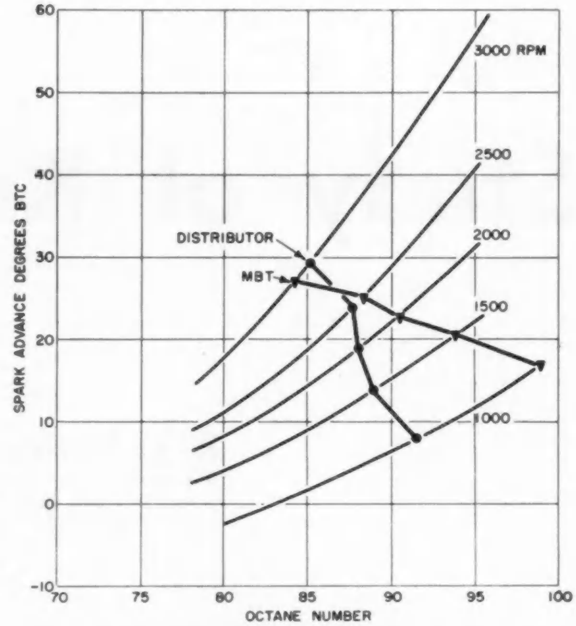


Fig. 5—Effect of spark advance on primary reference fuel requirement for normal operating speeds of engine make D.

shown in this figure. The fuel shown changes its rating rather quickly in terms of primary reference fuels as engine conditions are altered and for this reason it would be called a sensitive fuel. Fuel sensitivity for automotive fuels is commonly expressed in terms of "jump," meaning the difference between the Research Method rating and the Motor Method rating. In this instance the fuel sensitivity is 12 octane numbers.

"S" Reference Fuel Series

By rating a series of sensitive fuels in terms of primary reference fuels in a third engine it is possible to represent the third engine in its relation to the Motor Method engine and the Research Method engine. For this purpose we have found the "S" reference fuel series shown in Fig. 3 to be quite useful. The "S" reference fuels are all blends of three pure hydrocarbons: isooctane, normal heptane, and diisobutylene. The amount of the three components is adjusted to give the desired Research octane number and the desired sensitivity for each fuel blend. The sensitivity is approximately the same as the average commercial fuel of the same Research octane number. The composition and laboratory ratings of the fuels shown are included in Table 1.

Automotive Engine Ratings of Fuels

In order to rate automotive fuels of different octane numbers in the Research and Motor Method laboratory test engines the compression ratio is increased until knock occurs. This is done while maximum knock fuel-air ratio and a specified spark advance are maintained.

Various methods resembling the Modified Borderline Method, or the Modified Uniontown Method, all of which require a change in spark advance to cause the fuel to knock, are normally used for automotive engine testing of the antiknock properties of fuels. The same general procedure was followed in dynamometer calibrations of some 1955 passenger-car engines. The details of the calibration at 1000 rpm are illustrated in Fig. 4. Using the carburetor supplied with the engine, speed was held constant and the engine was operated at full throttle on various blends of primary reference fuels. For each blend the spark was manually adjusted until the fuel knocked and the degrees of actual spark advance required to cause knock for each blend of isooctane in normal heptane are shown in this figure. The spark advance which would have been obtained, if the distributor had been set at the manufacturer's recommended basic setting and had followed the standard distributor advance curve, is also marked. Reading along the horizontal scale it is indicated that the engine requirement at 1000 rpm is 91 octane number at this speed. Dynamometer calibration also permits the determination of maximum power spark advance. If the distributor had been set to give the minimum spark advance required to produce maximum power (a spark advance commonly referred to as "minimum for best torque" and hereafter indicated simply mbt) the engine would have required 99-octane primary reference fuel.

In actual test work the spark advance for knock on a single primary reference fuel is determined at each of several speeds before changing to the next reference fuel. The results of the complete calibration over the speed range for engine make D is shown in Fig. 5. The primary reference fuel requirements for this engine at the standard distributor setting and at the minimum spark advance for best torque are shown at each of five speeds.

Fig. 6 indicates the spark advance required to

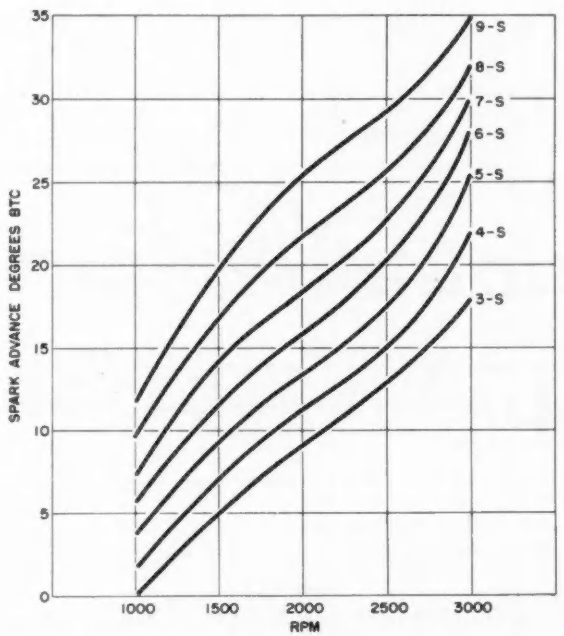


Fig. 6—Knock-limited spark advance for "S" series of sensitive reference fuels in engine make D.

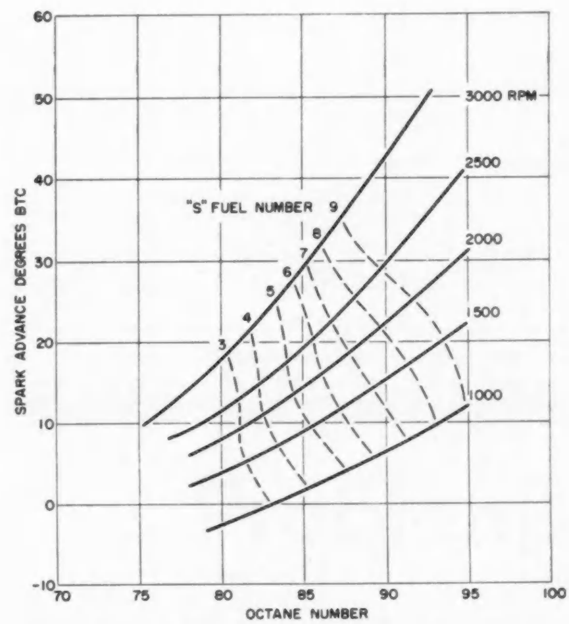


Fig. 7—Primary reference fuel ratings of "S" series of sensitive reference fuels in engine make D.

cause knock for seven of the sensitive reference fuels at each of five engine speeds.

Since Fig. 5 related octane-number requirement to spark advance and engine speed it is possible by superimposing Figs. 5 and 6 to determine the octane-number ratings of each of these sensitive fuels at each engine test condition. This is illustrated in Fig. 7 where, for example, it may be seen that S-7 which knocked at 7 deg at 1000 rpm is found to rate 91 octane number. At 3000 rpm it knocked at 30 deg spark advance and it is therefore 85 octane number.

Relative Severity of Passenger-Car Engine, Make D

Referring again to Fig. 2 we find that if a straight line is drawn through the Research Method rating and the Motor Method rating for a given fuel, the octane-number rating of the same fuel in a third engine could be plotted at the proper location on this line. The ratings obtained in engine make D at 1000 rpm for all seven of the sensitive reference fuels have been plotted on the proper fuel sensitivity lines in Fig. 8. The approximate spark advance in degrees causing four of these fuels to knock is indicated just to the right of the line connecting these points. This line represents the "severity" of this engine at 1000 rpm relative to the Research Method and to the Motor Method. It will be noted that sensitive fuels are rated relatively lower as spark advance is increased. Stated in another way, fuel 3-S rates 3 octane numbers above the Research octane number when spark occurs at top dead center, while fuel 9-S rates slightly below its Research rating with the spark advanced to 12 deg before top dead center.

Effect of Spark Advance on Severity—When all the speed lines are constructed in this same manner for

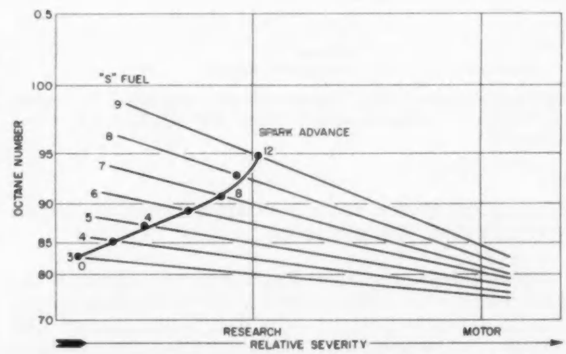


Fig. 8—Engine make D severity line established by ratings of sensitive reference fuels at 1000 rpm.

engine make D they form the engine severity pattern shown in Fig. 9. Each speed line follows the same trend noted previously. As spark advance is increased to cause the better fuels to knock, fuel ratings become relatively lower and approach the Motor Method octane number of the fuel. For example, at 3000 rpm 3-S knocked at 18 deg and rated at Research rating level while 9-S knocked at 35 deg and rated only 3 octane numbers higher than its Motor Method ratings.

Effect of Engine Speed on Severity—Just as increased spark advance normally increases engine severity (or lowers sensitive fuel ratings), engine speed also increases engine severity. Increasing engine speed from 1000 to 3000 rpm has almost as

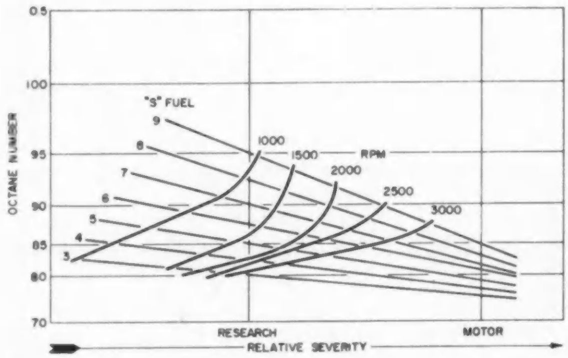


Fig. 9—Engine make D severity pattern established by ratings of sensitive reference fuels at normal operating speeds.

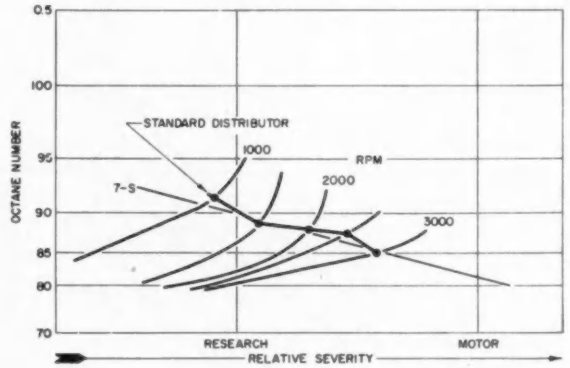


Fig. 10—Engine make D fuel requirement at standard distributor spark advance.

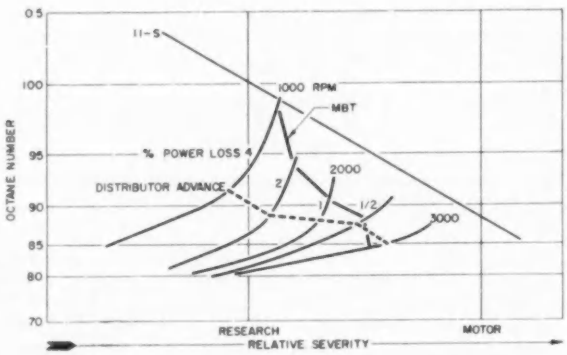


Fig. 11—Reduction in fuel requirement for engine make D resulting from choice of distributor advance below that which results in best torque.

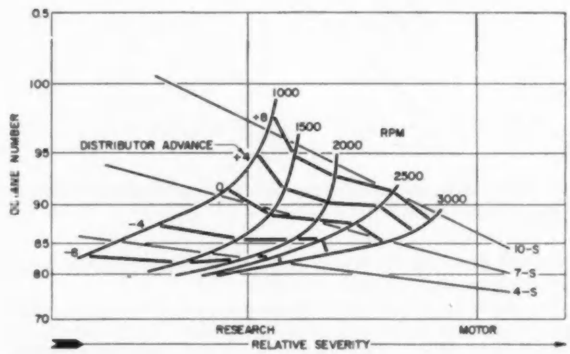


Fig. 12—Effects of basic spark advance changes on fuel requirements of engine make D.

much effect on fuel ratings as the difference between Research and Motor ratings.

Determination of Fuel Requirement—The fuel requirement of this engine is readily transposed to the engine severity pattern. In Fig. 5 was shown the primary reference fuel requirement for the distributor setting at each speed. Since the speed lines have been constructed the reference fuel requirement may be shown as indicated in Fig. 10. It will be seen that fuel 7-S is likely to knock at low speed between 1000 and 1500 rpm. Knock would then be expected to die out and start again between 2000 and 3000 rpm.

Effect of Power Loss on Requirement—In Fig. 5 the distributor spark advance and the minimum spark advance for best torque were shown. The octane-number requirements for these spark advance values have been transferred to the engine severity plot in Fig. 11. If the engine builder had decided to set the distributor to obtain maximum performance, the engine would have required a fuel of 100 Research octane number. This is illustrated by the 11-S fuel line. The distributor curve actually chosen results in a power loss of 4% at 1000, 2% at 1500, and essentially no loss from there up to 3000 rpm. These are all full-throttle values. By making this compromise on power, the fuel requirement is reduced by about 8 Research octane numbers. With a 92 Research octane number fuel, however, knock could be expected at high speed if the Motor Method octane number fell below about 82.

Effect of Basic Spark Advance on Requirement—By utilizing the information given in Fig. 5 relating spark advance, octane-number requirement, and distributor setting, the effects of basic spark advance changes on fuel requirements of the engine may be shown graphically as in Fig. 12. The standard distributor set at the manufacturer's basic recommended timing will follow the zero line, as has been discussed. If the basic setting is retarded 4 deg the fuel requirement will follow the line "minus 4." If the basic setting is advanced 4 deg, the fuel requirement will follow the line "plus 4." With the Modified Uniontown technique the basic distributor setting might be advanced by 8 deg. Under these conditions the engine would knock at low speed on a fuel of 98 Research and 85 Motor. If retarded by 8 deg the engine would knock on any fuel lower than 83 Research and 83 Motor. For example, it would knock at high speed on fuel 4-S.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

E. R. Heald, Douglas Aircraft Co., Inc.

Based on paper "Stability and Control of Piloted Aircraft at High Altitudes" presented at the SAE Colden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

High Altitudes Increase Airplane Stability Problems

AN airplane's flying qualities change at very high altitudes because the air is less dense and it's colder. Because the air is less dense, the plane operates on a less favorable part of the lift-angle of attack curve. So the plane must have a higher angle of attack. This increases static stability problems.

To appreciate the affect of altitude on flying qualities, it is necessary to get a clear picture of the changes in airplane operating conditions with changes in altitude. Basically, changes in altitude cause changes in air density and, to a lesser extent, ambient temperature. At 100,000 ft, for example, air is only 1/70 as dense as at sea level.

Although reduced density is the basic factor underlying changes in flight behavior, it is convenient to assume indicated airspeed ("equivalent" airspeed as defined by the NACA) constant at some typical value and consider the entire effect of altitude to reflect as changes in true airspeed and Mach number.

For steady level flight, lift must equal weight. And since maximum lift coefficients are fairly constant, dynamic pressure and indicated airspeed must remain above certain minimum values. Maximum values of dynamic pressure and indicated airspeed, however, will be limited by performance considerations and the indicated speed range will be fairly narrow.

How true airspeed varies with altitude is shown in Fig. 1. The minimum practical flight speed is assumed to correspond to a 150 knot indicated speed while the maximum values are left indefinite because of their dependence on the propulsion system. Note that flight at 100,000 ft requires Mach numbers greater than 2.0.

Another change in airplane operating conditions results because of the effect of Mach number on lift curve slope. At supersonic speeds lift curve slope decreases steadily, and although flight is assumed at constant indicated speed and thus at constant lift coefficient, angle of attack increases.

Typical variations of lift curve slope and angle of attack for constant lift coefficient are shown in Fig. 2. This reduction in lift curve slope plus the need for using all available lift coefficient for maneuvering means that high altitude lifting airplanes will operate at high angles of attack as a matter of routine.

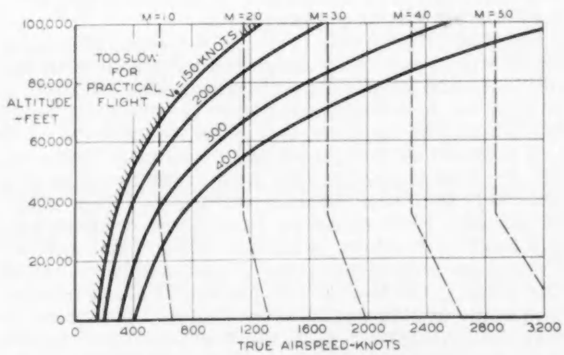


Fig. 1—A high altitude lifting airplane operates at the same indicated airspeed as its low altitude counterpart but travels at much higher true airspeeds. Here, minimum practical flight speed is assumed to correspond to a 150 knot indicated speed. Note that flight at 100,000 ft requires Mach numbers greater than 2.0.

So, the high altitude lifting airplane operates at the same indicated airspeed as its low altitude counterpart but travels at much higher true airspeeds and Mach numbers. It also operates at much higher angles of attack than the low altitude airplane except possibly in take-off or landing.

Static Stability

Static stability is influenced by Mach number and angle of attack, both of which increase with altitude. Mach number, as noted earlier, causes a steady re-

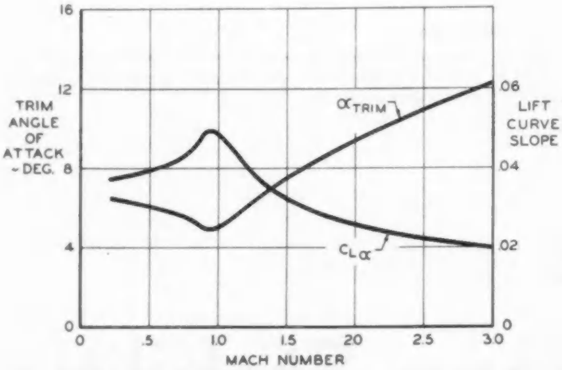


Fig. 2—The reduction in lift curve slope at Mach numbers greater than 1.0 plus the need for using all available lift coefficient for maneuvering means that high altitude lifting airplanes will have to operate at high angles of attack. Note that a tail surface will provide only half the stabilizing moment at Mach 2.0 as at Mach 1.0.

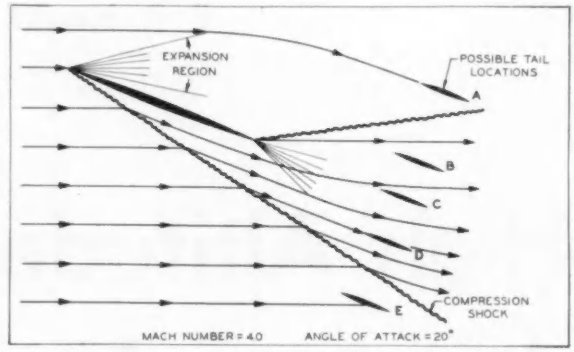


Fig. 3—The flow field around the wing at this angle of attack and Mach number reveals that the optimum practical location for the horizontal tail appears to be on or near the extended wing chord line near location C. Unless it is properly located, expansion and compression waves may interfere with the tail.

duction of lift curve slope once supersonic speeds are reached. Since the tail surfaces provide stability in direct proportion to lift curve slope, serious stability problems can arise at high altitude. Fig. 2 shows that a tail surface provides only half the stabilizing moment at Mach 2.0 as at Mach 1.0, and proportionately less at higher speeds.

Another unfavorable factor is the angle of attack effect which can cause large reductions in both directional and longitudinal stability. Tail blanketing or location in adverse downwash or sidewash fields at high angles can have serious consequences.

A problem of horizontal tail location is shown in Fig. 3. This shows the flow field around a wing at a relatively high supersonic speed and at 20 deg angle of attack. Flow direction lines show qualitatively the angles of attack experienced by a tail surface located at several possible vertical positions aft of the wing. Note that at this particular Mach number and angle of attack, the expansion and compression waves may interfere with the horizontal tail, unless it is properly located. Local angles of attack at the tail and therefore its effectiveness may be seriously reduced. A tail located high at position A would be severely affected as would one at location D. The optimum practical location for the set of conditions shown appear to be on or near the extended wing chord line near location C.

In addition to the downwash field the tail may experience relatively large dynamic pressure variations. Fig. 4 shows approximate dynamic pressure variations behind the wing. In the expansion region dynamic pressure is reduced, while abrupt increases occur through the compression shocks. So with respect to both downwash and dynamic pressure a position near the extended chord line seems optimum.

There are also appreciable variations of local Mach number in the vertical plane behind the wing. Tail lift will be affected by the local Mach number, the angle of attack, and the dynamic pressure. The problem of accurately estimating tail effectiveness is thus seen to be quite formidable.

Directional stability may be even harder to obtain

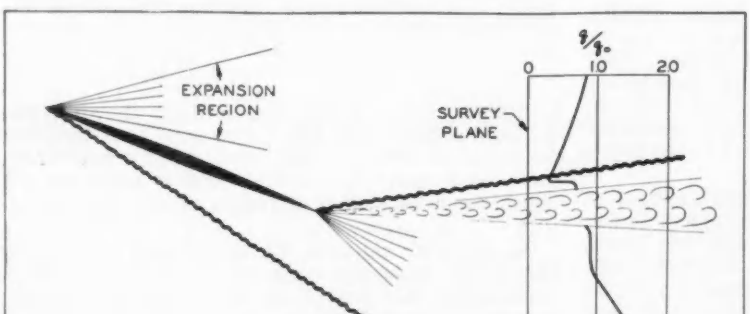


Fig. 4—Dynamic pressure variations behind the wing indicate that the pressure is reduced in the expansion region while abrupt increases occur through the compression shocks. Here too, a tail position near the extended chord line seems optimum.

at high altitudes than longitudinal stability. Fig. 5 shows a typical variation of directional stability with Mach number and indicates the trend toward instability caused by tail lift curve slope reduction. When it is considered that half of the low speed tail effect is required to offset the destabilizing fuselage moment, which, unfortunately, remains almost constant, the tendency toward instability is readily appreciated.

The effect shown by Fig. 5 occurs at zero angle of attack and can be much worse at high angles. The conventional and convenient tail location on top of the fuselage usually results in large blanketing effects at high angles, particularly with low aspect ratio wings. Not only is the local dynamic pressure at the tail reduced but the unsymmetrical displacement of the wing-fuselage vortex relative to the tail when sideslipping causes large sidewash effects. So location of some stabilizing area below the fuselage may become almost mandatory.

This creates difficulties relative to take-off and landing but such problems are by no means insurmountable. For efficient operation the high altitude airplane should be designed specifically for high angles of attack. Designers should recognize the importance of good basic flight characteristics and be willing to seek new arrangements capable of meeting the demands imposed by high altitude, high speed flight.

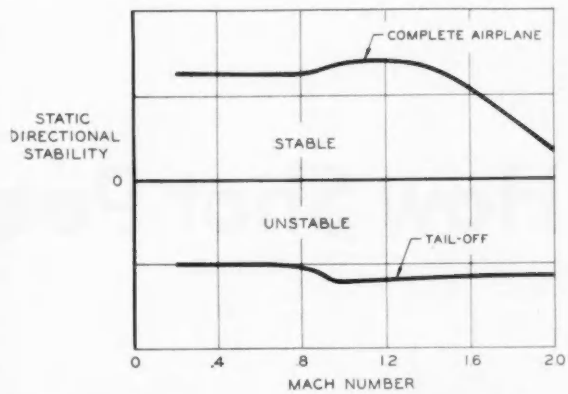


Fig. 5—This typical variation of directional stability with Mach number indicates the trend toward instability caused by tail lift slope reduction. This effect is for zero angle of attack and can be much worse at high angles of attack.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

Tournamatic Transmission . . .

. . . provides drive with flexibility of ratios and simple finger-tip control for all types of heavy earthmoving and construction machinery.

Based on paper by **John H. Hyler,** LeTourneau-Westinghouse Co.

THE Tournamatic transmission is a constant-mesh multiple countershaft type that shifts under power by means of air actuated multiple disc clutches controlled by a single rotary air valve unless remote control or twin units are involved.

Reverse ratios can be made to duplicate the forward speeds in first and second gear, or for the full range. It is also possible to provide just two reverse speeds that will be intermediate of the speeds forward.

Among the advantages of this type of drive are flexibility of ratios, wide spread of ratios (the ratio of ratios in the Model 7C being as high as 11.93:1), built-in offset drive and maximum accessibility. There are many operational advantages, both in the dozing, pushing, and heavy drawbar service of the Tournatractor, and the scraper and hauling service of the Tournapull. These are due largely to being able to power-shift over a very wide speed range by moving one simple selector lever.

Comparison of performance with conventional transmissions needs to be made on the basis of the contractor's overall operations and with regard to the preferences of personnel. (Paper "Tournamatic Drive for Tractors" was presented at SAE Central Illinois Earthmoving Industry Conference, Peoria, April 3, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

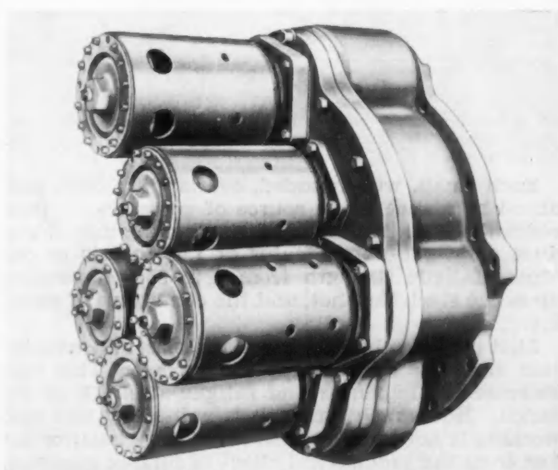


Fig. 1—Compact and accessible, the Tournamatic transmission affords power-shifting over a wide speed range on rugged work with earthmoving machinery.

How Shot Peening Improves

Formation of residual compressive stresses is most important factor

THREE WAYS in which shot peening may be expected to influence fatigue strength are:

1. **Surface roughening.** Each shot makes a slight indentation so that the peening operation roughens a previously polished surface. This would be expected to lower the fatigue strength.

2. **Surface work-hardening.** Each indentation distorts the metal and produces work hardening (and sometimes other structural changes) in near-surface layers. This may increase fatigue strength or in special cases may decrease it.

3. **Residual stresses.** The yielding of surface metal leaves macroscopic residual compressive stresses. These stresses are probably the most important factor in improving fatigue strength by shot peening.

Each small, well-rounded, overlapping dent produced by a shot is the source of geometrical stress concentration. This surface roughening may introduce a fatigue-notch factor of 1.04 to 1.40 or decrease fatigue strength from 4 to 35% depending upon the steel, the shot, and the conditions of peening.

Shot peening changes the shape, size, and orientation of grains at and near the surface. This may increase the hardness and fatigue strength of the metal. How much strength is gained by this cold working is not known; however, it may balance the loss from the geometrical effect of surface roughening. So, the determining factor of fatigue strength may then be the residual stresses induced by the peening.

Residual Stress

Shot peening causes plastic flow in the surface of the metal which stretches the subsurface core longitudinally. Subsequently the elastic core material tries to force the deformed material back into shape. As a result surface metal is in compression and core material is in tension after the peening. Actually the residual stress is biaxial at the surface and triaxial beneath. To simplify this discussion we shall consider just the longitudinal residual stress in a simple bar specimen.

Fig. 1 shows the residual stress pattern that might exist in a bar of steel shot peened on the top side only.

Let us consider the stresses at various locations in this bar when it is bent repeatedly so that the load stress at the top varies from zero to 200 ksi tension. When the applied load is zero, the stresses will be those indicated by the broken line labelled "residual stress." At maximum load, the stresses will be those shown by the solid line labelled "resultant stress." (To simplify the discussion further

Fatigue Strength

H. J. Grover, Battelle Memorial Institute

Based on paper "Factors by Which Shot Peening Influences the Fatigue Strength of Parts" presented before Division 20—Shot Peening & Blast Cleaning—SAE Iron and Steel Technical Committee, Sept. 28, 1954.

we assume that the residual stress does not change during the repeated-loading test.)

From Fig. 1, a table of values of cyclic stresses in the peened bar and corresponding stresses in a similarly loaded unpeened bar can be made. (See Table 1.) At most points in the upper half of the bar both maximum and minimum stresses are different for each case. The residual stress (which was considered constant) has shifted the total mean stress in the loading cycle but has not influenced the amplitude of stress.

To evaluate the influence of residual stress on fatigue strength, it seems in order to consider the influence of mean stress on stress amplitude in fatigue. In Fig. 2, straight lines are drawn through a value for tensile strength and values from fully-reversed-loading fatigue tests.

Before considering the effect of peening, consider an unpeened bar loaded so the top surface varies from zero to tension. (In Fig. 2, the line OA.) At a maximum stress level of 200 ksi (mean stress of 100 ksi plus stress amplitude of 100 ksi) failure will occur at point A in about 15,000 cycles. This is the lifetime expected for an unpeened bar. For conditions corresponding to a lifetime of 200,000 cycles (point B) the mean stress is 85 ksi, stress amplitude is 85 ksi and maximum stress is 170 ksi.

Fig. 3 illustrates part of this same Goodman-type diagram with a heavy curve representing stress conditions at various depths in the shot-peened specimen. This was obtained from Table 1. The upper left starts at the surface, the line bends back sharply at a depth between 0.02 in. and 0.03 in. below the surface. It appears that this curve will just touch a Goodman line corresponding to a lifetime of about 200,000 cycles. This point of intersection will correspond to a depth of about 0.015 in., a mean stress about 97 ksi, and a stress amplitude about 80 ksi.

Thus the calculation indicates a lifetime of about 200,000 cycles for the shot-peened specimen compared with about 15,000 cycles for an unpeened specimen. The nominal maximum stress for the peened specimen is 200 ksi; for an unpeened specimen living as long, it would be about 170 ksi. Peening may be said to have increased the lifetime more than 13 times or to have increased the loading stress withstood at a specified lifetime about 15%.

Note that the calculation predicted a subsurface failure. Such failure is found often in shot peened specimens—especially stress-peened ones which have high residual stresses.

This simplified calculation shows a number of items useful as guides in improving fatigue life by

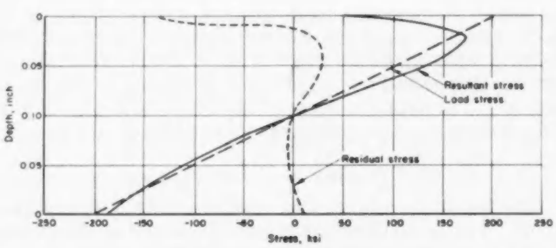


Fig. 1—Stresses in a shot-peened bar. When the applied load is zero the stresses will be those indicated by the broken line labelled "residual stress." At maximum load the stresses will be those shown by the solid line labelled "resultant stress."

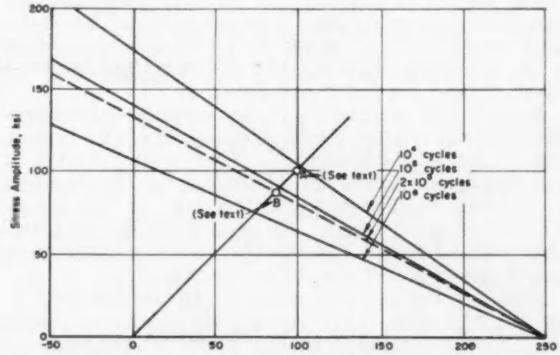


Fig. 2—Simplified Goodman diagram for high-strength steel.

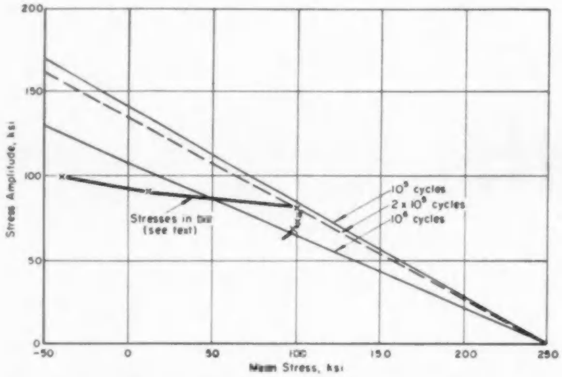


Fig. 3—Goodman diagram with heavy curve representing stress conditions at various depths.

Table 1—Cyclic Stresses in Peened and Unpeened Bars (Data Obtained From Fig. 1)

Depth Below Top Surface, in.	Stresses, ksi			
	Unpeened Bar		Peened Bar	
	Minimum	Maximum	Minimum	Maximum
0	0	+200	−140	+ 60
0.01	0	+180	− 75	+105
0.02	0	+160	+ 15	+175
0.03	0	+140	+ 25	+165
0.04	0	+120	+ 30	+150
0.05	0	+100	+ 30	+130
0.06	0	+ 80	+ 25	+105
0.08	0	+ 40	+ 10	+ 50
0.10	0	0	0	0

shot peening. Improvement of residual stresses should be expected mainly when the loading produces a stress gradient. The bar used as an example might have its tension fatigue strength lowered by peening: it would be expected to fail under tension beneath the surface at the region of maximum residual tension. Under fully reversed bending it would be expected to fail at the bottom unpeened surface (at a slightly shorter lifetime than that of an unpeened bar). In general, peening should be effective in bending and torsion where there is a considerable stress gradient. However, it should be helpful also in axial loading of notched specimens where the geometry imposes a gradient of loading stress. The approach used in this example could be applied to other loading conditions.

Shot Peening in Actual Practice

The example given was oversimplified in several ways. For one thing a simplified Goodman diagram was used. We were unable to find an instance in which there was experimental evidence of the improvement of fatigue strength by shotpeening, the residual stress actually produced by the same peening, and a Goodman diagram for the steel in the same general condition. A straight-line diagram may not be a very good approximation. However, this oversimplification can be avoided in the future when adequate data on the effect of mean stress upon fatigue strength are obtained.

Next it was assumed that the residual-stress pattern did not change during the course of the fatigue test. This is not always so. Even a single cycle of applied stress above the yield point of the peened metal will remove the greater part of the longitudinal residual stress. No serious reduction probably will be found for applied stresses lower than about one-third of the yield strength.

Also, the transverse residual stresses introduced by peening were neglected in this example. There is relatively little information about biaxial residual stresses from peening or about the effect of biaxiality of residual stresses from any source upon fatigue strength. However considerable work is being done at Battelle Memorial Institute on the effect of combined stresses in fatigue.

It was assumed that the surface of the metal prior to peening was smooth, polished, and free from decarburization so that fatigue improvement was simply based upon comparison with fatigue strengths of polished specimens. It also was assumed that peening was complete and uniform and of suitable intensity to provide high residual stress without overpeening. In practice these conditions may not be possible.

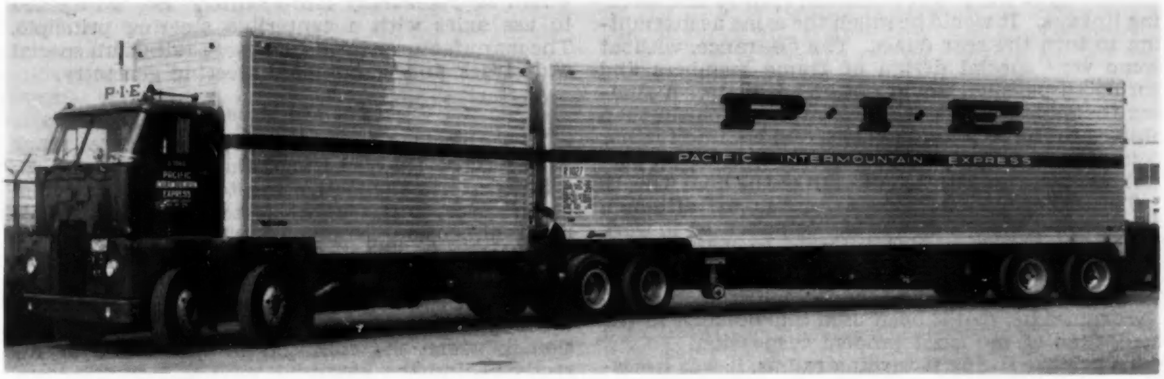
Peening has been effective on various types of surfaces. Carburized gears, decarburized springs, induction-hardened specimens, a notched flame-hardened specimen, straightened automobile axles, and other unpolished parts have been reported to have received increased fatigue resistance from shot peening.

Experiments at Battelle showed the effect of lack of complete coverage in shot peening spring leaves. Even when areas as small as about 1/10 in. square were left unpeened, the specimens failed fatigue tests at those areas.

Numerous observations have suggested that for a specific application there is an optimum peening. Too-low intensity of shot and too-few passes do not produce as extensive work hardening and as high and deep compressive stresses as would give maximum improvement in fatigue resistance.

There are so many complicating factors in many applications of shotpeening that it doesn't seem likely, within the immediate future, we will be able to predict fatigue behavior and its improvement by shot peening accurately enough to do away with experimental tests in any new application. Nevertheless, progress is being made which will guide necessary empirical testing and may reduce the number of experiments necessary to develop a new application of shot peening.

(For complete paper on which this abridgment is based write SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)



Here is the prototype dromedary tractor designed and built by Pacific Intermountain Express Co. It is shown carrying a semi-trailer combination utilized west of Denver. Twenty of these tractors, built to the specifications of this prototype, have been ordered from two heavy-duty truck manufacturers.

"How we arrived at the various design elements in

P-I-E's Prototype Dromedary"

L. H. Peterson

Former Superintendent of Engineering, Pacific Intermountain Express Co.

Excerpts from paper "A New Approach to Truck Design when Precedent Isn't a Controlling Factor" presented at the SAE Northern California Section, Sept. 28, 1955.

A NEW prototype dromedary tractor design was completed last year by Pacific Intermountain Express Co. It was aimed to gain maximum payload and space in keeping with existing length and weight laws in the western states. The greatest possible reduction in sensitivity to load was also a major aim of the designers.

Every element of the design was developed to point as directly as possible toward maximum development of these goals. (The project was carried out in the P-I-E General Shop in Denver.)

Length and Gross Weight

The laws in the western states through which P-I-E routes extend provide for tractor, semi-trailer lengths up to 60 ft and graduate allowable gross weight either by table or bridge formula based on over-all axle spacing in general accordance with this maximum length.

So, one prime requisite of the experimental tractor was an exceptionally long wheelbase.

This brought up the question of acceptable turning radius limits. We set as a target a 50 ft turning radius. Then, with further thought to the off-tracking characteristics, settled on a wheelbase of 297 in. from centerline of first axle to centerline of rear tandem axles. In the final layout, this provides for a cargo box with length of 17 ft and volume of approximately 1025 cu ft, making available a total volume of 3300 cu ft when in combination with our late model trailers.

Tandem Front Axles

The obvious answer to the problem of front axle loading is increased capacity.

The apparent choices are tandem steering axles or a high capacity single axle with either large single tires such as 12:00 × 20's or dual tires of normal size for highway use.

Each of these possibilities was considered. Then the decision was made to build the experimental unit with tandem front axles. The reasoning was as follows:

Only brief consideration was given to large single tires as a means of increasing front axle loading since there was general aversion to having odd size tires on the vehicle and in inventory at west end stations for replacement. Use of dual tires on a large single front axle was more seriously considered, but was finally given up in favor of tandem axles. Reasons: the problem of providing adequate cramp angle for steering a relatively long wheelbase chassis and the adverse steering characteristics that were visualized.

The restriction to cramp angle is readily apparent if the width between the inside duals is considered

in relation to the width outside of springs and steering linkage. It would be much the same as attempting to turn the rear duals. The clearance, without some very special design of frame members and spring suspension, would not be adequate. Assuming that this could be worked out, the problem then shifted to the steering knuckles and became further complicated with the need for hubs that would permit independent rotation of each of the dual wheels.

The tandem front axle arrangement, although heavier in comparison, was less complicated to work out to a point relatively free of compromises. Also, it reduced frame stress due to the effective support points being shortened by the 24 in. increment from the front axle, had it been used individually, to the centerline of the front tandem suspension.

To achieve the 50 ft turning radius, it was necessary to facilitate a major cramp angle on the leading axle of 35½ deg. To avoid excessive tire scuffing, cramp angles of all four front wheels were synchronized as closely as possible throughout the steering range. It was also considered desirable to attain reasonable steering ease without the use of power steering. (In the event of failure of the power unit, the problem of maintaining control would be potentially more acute.) So, we elected to use axles with a centerline steering principle. The manufacturer furnished these axles with special wide track and coordinated steering geometry.

Engine and Mounting

It was decided to power the experimental truck with a turbo-charged NT600 Cummins engine.

Since a prime objective was to provide maximum cargo space, it was desirable to achieve the minimum dimension, consistent with driver comfort, from the bumper to back-of-cab. Consideration was given initially to a cab-over-engine arrangement with the radiator displaced from its normal location and the engine moved forward to a position in which the vibration damper would be directly behind the bumper. With this engine location, a 56 in. bumper to back-of-cab dimension appeared feasible. However, in addition to the problems encountered in providing a new radiator location, maintenance accessibility seemed to become more complicated than in standard cab-over-engine models due to the additional axle and suspension members below the engine and transmission plus the restrictions at the sides of the engine.

After rechecking the weight distribution, it was decided to use the horizontal engine, mounted underneath the frame. Contributing to this decision was the improvement possible in the propeller shaft by shortening the required length.

In the final layout, it appeared possible to avoid using a drive-shaft center bearing, which was a prospect with definite appeal. Prior to this time, Cummins had not furnished the pancake NH engine with a turbo-charger. Now, they built up a special turbo-charged version of the NHH engine, with an assigned model designation of NHHT. The engine for our experimental tractor carries the turbo-charger in a position which obstructs to some extent access to the rocker arms and heads. However, it is our understanding that this will be changed in future production of the NHHT engine.

Transmission and Mounting

Selection of transmission components culminated in the use of the ten-speed Roadranger, Model R95C. This transmission provides single lever control and well spaced gear changes.

But, of perhaps greater importance in this particular installation, was the requirement for a single remote control mechanism as compared to two such systems for a main and auxiliary transmission combination. Transmission remote controls at their best generally rob, to some extent, the feel and ease of shifting which are obtained with a lever extending directly from the transmission to the driver. Because of the distance in this case between the cab and transmission, it was evident that additional guides, joints or relays would be needed and would further add to frictional losses in the system. So, two such systems, one of which would be even longer, appeared somewhat undesirable.

The ten-speed transmission did, however, pose a mounting problem of more than normal proportions. Since the engine and transmission were to be unit mounted in an area of relatively high frame deflection, it may be visualized that the transmission rear support must accommodate movement between the frame and transmission of appreciable magnitude

The Word "Dromedary" ...

. . . as used in this article, does not refer to a "single humped camel." Rather, it describes a type of highway tractor which has a hump in the form of a cargo box on its back.

Pacific Intermountain Express Co., recognizing the disadvantages as well as the economic advantages of its fleet of 60 dromedaries, undertook to design and construct an experimental tractor which would be a prototype unit for subsequent purchases.

This is the story of that prototype design job . . . with the reasoning which led to final incorporation of each of its major elements.

The dromedary tractor is simply a means of taking advantage, payloadwise, of additional weight and length allowed in the western states as compared to those in the midwest and east.

Normally, the cargo box on the tractor is loaded with freight and moving between terminals on the west end. Through trailers may then be loaded to conform with weight laws on the east end, and move with uninterrupted schedules.

As developed by the Pacific Intermountain Express Co., a standard cab-over-engine, 3-axle chassis constitutes the basic structure of these tractors.

The 250 in. wheelbase with a fifth-wheel setting 12 in. behind the bogie trunnion provides adequate space between the back of the cab and the nose of the trailer for a box 11 ft 6 in. long . . . and makes available 650 cu ft of additional volume. The overall length of the combination, with a 35 ft trailer, is 56 ft 4 in.

without imposing excessive stresses on the engine mounts. To cope with this condition, we adopted a common coil spring arrangement similar to many such supports in general use. Also, we incorporated springs somewhat longer than usual to better regulate the tension within the required compression range.

Frame

Need for adequate frame strength gave reason for some serious thought due to the proposed loading and the 273 in. span between support centers. To hold down weight, the preference was for aluminum side rails, and, insofar as practical, aluminum cross-members.

By integrating the rigidity of the cargo box into the analysis of frame moments, it appeared that aluminum alloy channels (used for several years in West Coast model trucks) could be used in this tractor. However, in view of the elasticity of aluminum, the deflection was expected to be high.

The frame assembly, as it was finally built, incorporated aluminum cross-members in all but two positions and aluminum alloy siderails of extruded channel with a section modulus of approximately 29.5.

Spring Suspension

For suspension units, we wanted air springs, following our changeover to air springs in trailers. The advantages visualized were better ride characteristics, uniform frame height and reduced maintenance. Since the rubber air cells comprised the only items that could be adopted from existing material, it was necessary to start almost from scratch in developing the suspension units.

In the final plans, materially different designs were conceived for the front and rear airrides. The front suspension incorporated a single air cell and lower beam assembly on each side. The rear suspension employed individual air cells and compression chambers for each axle on each side.

Sway stabilization was provided on the front by two rubber cushioned rebound rods which straddle the spring and limit the mean height between the frame and lower beam assembly. U-shaped sway stabilizer rods similar in principle to those used on passenger cars were employed on the rear axles. The rear stabilizer rods also act as lower torque arms.

Two leveling valves were used on the front suspension and a single height control valve was used on the rear. Lateral and longitudinal alignment of both units is provided by torque arms and radius rods.

Cab

A 56 in. bumper-to-back-of-cab dimension was mentioned previously in connection with the contemplated use of an upright engine. With the subsequent change to a horizontal engine, the cab front to rear dimension was contingent only on the space requirements of the driver. After studying the room needed for steering wheel positioning and driver seating, we settled on a 50 in. fore and aft dimension for the cab which resulted in a 54 in. bumper-to-back-of-cab dimension. An inside cab height of 55 in. and over-all width of 84 in. were adopted in the final layout.

To provide good driver visibility, the cab was designed with set-back corner posts to improve the side angle of vision and very deep windshields for good vision downward in front of the truck. The windshields were curved back at the outer ends to conform with the 6 in. radius corners and set-back corner posts.

The cab was constructed of aluminum throughout, using 61ST6 alloy which has relatively good weldability and forming characteristics. Fiberglass insulation was provided between outer skin and interior lining. A heater mounted between the driver and passenger seats at the back of the cab is most effective in that the warm air is propelled forward against the front panel and then deflected around the sides of the cab. So, a heater installation of this type was provided.

Cooling System

Because continued fan operation makes waste of the 15-plus hp normally consumed in fan drive, we attempted to work out an electrical fan drive system that would automatically shut off when the shutters closed. This idea was further encouraged by the aspects of the mechanical system that would otherwise be needed to transmit power from the engine up to the radiator which was mounted in the normal forward position. The system with which the truck was put on the road utilized power from the 100 amp alternator, which is regular equipment on our trucks. Additional electrical components were a 110 volt d-c motor to which the fan was mounted, a rectifier and transformer and thermostatic switch.

Controls

To simplify clutch and throttle controls, hydraulic systems were used in place of mechanical linkage. The hydraulic components were adaptations of units that are supplied to the bus industry. The air clutch control was also considered, but given up due to lack of "feel" which was considered a significant factor in view of the difficulty in sensing engine rpm in the cab. A straight mechanical system was used for transmission shifting.

Final Chassis Weight

When completed, the tractor chassis with fifth wheel and 100 gal of fuel weighed 16,330 lb, distributed 8,380 lb front and 7,950 lb rear. An insulated cargo box, which weighed 2,550 lb, was mounted bringing the total weight up to 18,860 lb. This exceeded original weight estimates by approximately 800 lb due to changes in the specifications of the cargo box which was originally estimated at 1,600 lb.

Future Program

Since Aug. 1, 1956 P-I-E has had 20 more of these tractors in operation.

They will provide a broader basis of comparison with present equipment and perhaps point the way to wide scale replacement of our power units.

In conclusion, we might mention that P-I-E is experimenting with removable cargo boxes which are being considered to increase the utilization of the dromedary tractors.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members; 60¢ to nonmembers.

Precision Forgings Reduce

THE structural efficiency of airplane members is increased when the member can be forged as a single piece. Precision forging of large parts can result in big savings due to reduced machining costs. The additional cost of the equipment required for precision forging, however, must be weighed against required production to determine if it is economical.

Aircraft are getting heavier and faster. Structural members are being called upon to withstand greater loads—and often, to do the job in less space. The most inefficient part of any design exists at fastener type joints because a duplication of structural material is required. So, a design that combines structural components into a single part provides better structural efficiency. Also, elimination of splices reduces the sources of fatigue failure, and fatigue life of structure is becoming increasingly more important.

Forgings permit the elimination of bits and pieces thereby providing more efficient and economical structure. For example, Fig. 1 (left) shows the production break on the Boeing KC-135 airplane and Fig. 1 (right) shows the actual forging which has the better structural properties.

Airplanes are now in design stages that will require steel, stainless steel, and titanium alloy forgings because of elevated temperatures resulting from higher speeds. Above 400 F titanium forgings offer the greatest structural efficiency potential.

Progress in Forgings to Reduce Machining

Modern aircraft requirements have made reduction of machining one of the forging producer's foremost problems. But, with improved equipment and bolder development techniques, we are now beginning to see a brighter future in the reduction of machining costs through the further development of conventional forgings.

In 1953 questionnaires were issued to heavy press operators covering practically every phase of the subject of reducing machining costs. A comment on one of the questionnaires was "We are working toward the refinement of forging geometry. We can now produce draft angles as low as 3 deg on almost all designs, and efforts are being made toward attaining even lower draft angles. Aircraft wheels are being forged with draft angles as low as 1 deg in certain areas and work is under way to extend this to aircraft members."

In comparison look at the current wing root rib of Fig. 2.

Weight	145 lb
Width	12.5 in.
Length	90 in.
Web Thickness	0.22 in.
Die Closure Tolerance (web)	±0.010 in.
Area	945 sq in.

This spar is produced with ribs having 1 deg draft. By producing this part to closer tolerances cavity milling of the pockets has been completely eliminated resulting in a savings of 25% at the point of assembly over the cost of a standard tolerance conventional type forging.

A right and left spar is machined from one conventional forging weighing 340 lb. Individual conventional forgings for each hand would reduce the weight somewhat.

If several alternate forged designs will function equally well, without any sacrifice, the airframe manufacturers should consult with the producers to obtain the most economical part at the point of assembly. If performance requirements dictate a certain design regardless of cost, it then becomes

L. M. Christensen, Northrop Aircraft, Inc.

Based on secretary's report of panel on Forging Techniques To Reduce Machining held as part of the SAE Aircraft Production Forum, Los Angeles, Oct 11, 1955.

Machining Costs-

–but equipment costs must be measured against required output to determine if they are economical.

the obligation of the producer to arrive at the most economical manufacturing method.

Many factors control the production of close tolerance forgings and some of the predominant ones are:

Die Steels—Except where special die steel inserts can be used to advantage, there is no substitute for good Cr-Ni-Mo die steel. At 800 F this die material has a yield strength of 150,000 psi with a brinell reading of about 375 but it still has a tough time living under the high pressure required to forge thin webs.

Cast Dies—The new cast alloy dies such as aluminum bronze and beryllium copper are receiving much publicity and show some promise but still have a good many problems.

Knockouts—Knockout pins are used to advantage where the part tends to stick. Knockouts require additional mechanism and should only be used where there is an advantage to gain such as with press extruded type forgings.

Die Heating—Die heating has advanced greatly. It is now possible to hold constant temperature. This results in better die closure and more consistent shrinkage.

Lubrication—Much development work has been done but there is still great need for a lubricant with a higher flash point and a minimum of smoke.

Quenching Fixtures—It is highly possible that quenching fixtures in some cases can be developed

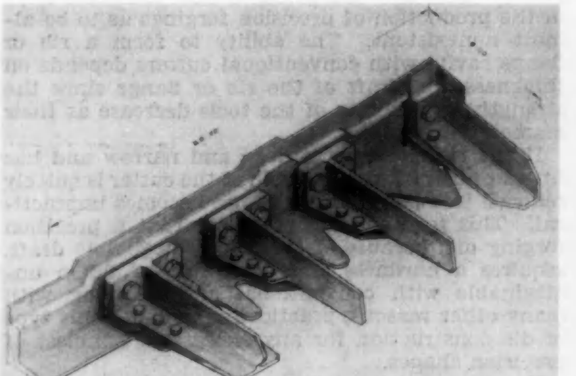


Fig. 1—On the left is the production break on the Boeing KC-135 airplane and on the right the actual one-piece forging. Forgings eliminate bits and pieces thereby providing more efficient and economical structure.

Serving on the panel on Forging Techniques To Reduce Machining which developed the information in this article were:

Chairman

J. Van Hamersveld, Northrop Aircraft, Inc.

Co-Chairman

A. Peterson, Lockheed Aircraft Corp.

Secretary

L. M. Christensen, Northrop Aircraft, Inc.

Panel Members

A. C. Carlson, Boeing Airplane Co.

P. B. Prough, Prex Forge

A. Favre, Aluminum Company of America

George Motherwell, Wyman-Gordon Co.

C. Mueller, North American Aviation, Inc.

C. F. Marschner, Lockheed Aircraft Corp.

Fig. 2—This wing spar is produced with ribs having 1 deg draft. By producing this part to closer tolerances the cavity milling of pockets has been completely eliminated resulting in a savings of 25% at the point of assembly over the cost of a standard tolerance conventional type forging.

to give the same results obtainable with the die quench method.

Die Sinking—Not unlike other mechanical operations where human skill plays an important part in producing a tool or machine the greater the accuracy the higher the cost. Precision dies average two to three times the cost of the dies used for the production of conventional forgings. Because of variation in producing a forging other than die inaccuracies it becomes a matter of economics as to just how much time and money can be spent in producing a die before reaching a point of no return.

All of the following variations, plus more, affect the accuracy of the forging delivered to the machinist.

1. Difference in shrinkage of one forging to another.
2. Die temperature.
3. Finish forging temperature.
4. Mismatch.
5. Die closure.
6. Die wear.
7. Distortion in heat-treatment of the part.

So each part is an individual problem and all factors up to the point of assembly must be considered carefully to arrive at a final decision.

Precision Forging Techniques and The Air Force Presses

With the availability of new hydraulic press equipment and particularly the Air Force 35,000 and 50,000 ton installations, it is natural that there should develop a strong desire to extend these advantages to really large and intricate forgings on which the machining cost on a single piece often runs into many thousands of dollars.

The following represents some of the major engineering and production problems which, in the light of experience on smaller parts, must be met and solved if the precision process is to be successfully applied to large forgings.

It is apparent to any designer of forging dies that the conventional construction of sinking the impression in a solid die block of steel is so restricted in the production of precision forgings as to be almost nonexistent. The ability to form a rib or flange cavity with conventional cutters depends on thickness and draft of the rib or flange since the strength and rigidity of the tools decrease as their diameters decrease.

If the rib or flange is deep and narrow and has little or no draft, the strength of the cutter is quickly reduced to a point where its use becomes impractical. This together with the fact that a precision forging die, because of its usually negligible draft, requires a hardness and perfection of finish unattainable with conventional cutters along with many other reasons, practically precludes this type of die construction for any except the simplest of precision shapes.

Usually, precision dies must be made in segments; that is, they must consist of multiple pieces, hardened, and ground to a high degree of accuracy and

a very smooth finish. These must then be assembled, held together accurately and strongly in some kind of holder or yoke. In tooling for the production of small parts, this is usually done in a circular yoke with the segments shrunk and pressed into place.

Such an arrangement is strong and satisfactory for small parts. With large parts and particularly with shapes having a great length to width ratio, the circular holder assumes dimensions bordering on the impossible.

Another major problem is the heating of dies and the maintenance of accurate die temperature. This is relatively simple with small dies where the results of considerable variations are often difficult to detect. However, such variation will prove disastrous with large dies and particularly in the spar sections. If the die and the stock are not at the same temperature, the dwell time must be controlled for overall dimensional accuracy of the piece as well as uniformity from piece to piece.

The heating system will have to be flexible and accurate to be adapted to a variety of shapes. Some specialized equipment for individual cases may be necessary. The precision process allows no margin for errors and this fact can never be lost sight of or neglected in any of the manufacturing operations.

The problem of heat-treating may be a formidable one. In some cases die quenching may have to be resorted to. In any case the most careful handling or well designed fixtures will be required.

The number of dies required to produce precision forgings depends upon design proportions, tolerances, and production requirements. If stock is not machined, one blocking die can sometimes be used. However, there have been instances requiring two sets of blocking dies. One set would be in the form of a slabbing die to distribute metal primarily along the plan area. The second set would be used to obtain accurate volumetric distribution of material prior to the finishing operation.

Because hydraulic presses have a slow ram speed, compared to other types of forging equipment, forgings can be produced with thinner webs and ribs. The slower metal movement resulting from the slow ram speed gives the metal time to flow more uniformly and reduces the tendency to create cold shuts, laps, and flow throughs.

Die material must be of the highest strength and hardness. This seems to preclude, at least for the time being, any extensive use of cast dies for large precision forgings. The use of cast dies is entirely possible for blockers for precision forgings where tolerances, although important, are not as close as for finish dies.

The full potentialities of the heavy presses cannot be realized overnight. It will be a long development and considerable caution should be exercised when one considers the extent to which revolutionary production achievements can be depended on for the near term future.

Production Design Considerations

Net forging refers to a class of press forged products which are usually produced without draft angles and to the dimensional tolerances normally applied to machined structural components used in aircraft. In Table 1 the use of net and conventional forgings on two different aircraft models, A and B, is compared by means of the ratio of finished part weight to raw forging weight.

The ratio of 0.47 shown for all conventional forgings for model A agrees quite well with a ratio of 0.50 determined by another manufacturer for a different airplane which was designed and manufactured about the same time. Note that the ratio of finished part weight to raw forging weight in-

Table 1—Comparison of Net and Conventional Forging on Two Different Aircraft Models—A & B

Model	Size of Forging	Total Per Airplane	Raw Weight Per Airplane	Finished Weight Per Airplane	Ratio Finished Weight to Raw Weight	Remarks
Net Forgings						
A	Small	32	53.6	23.4	0.44	Machine cuts to reduce raw weight to finished weight—only plain mill and drill. Fixtures simple due to absence of draft and closer tolerances.
B	Small	33	61.9	34.7	0.56	
Conventional Forgings						
A	Small	310	726.0	353.0	0.48	Machine cuts to reduce raw weight to finished weight. Requires contour milling, end milling, back spot facing, in addition to plain mill and drill operations. Fixtures must be adjustable due to presence of draft and large tolerances.
B	Small	277	1810.0	495.0	0.28	
A	Large	16	448.0	206.0	0.46	
B	Large	20	1020.0	580.0	0.57	
A	Small + Large	326	1174.0	559.0	0.47	
B	Small + Large	297	2830.0	1075.0	0.38	

NOTE: Model A first drawing release—Nov. 1950
Model B first drawing release—Sept. 1951
Large forging defined as over 30 in. long and/or over 40 lb.

creased 30% with improvement in net forging design and knowhow between models A and B while, at the same time, the ratio for conventional forgings in the same size range decreased 42%.

The increase in ratio of finished part weight to raw part weight for large size conventional forgings is attributable to the fact that these parts were designed for use in locations where the presence of draft angles and lack of close dimensional control created only local machining problems and machine sculpturing was, therefore, unnecessary.

Costs

From the producibility standpoint net forgings have their principal application where expensive types of milling operations are required to transform conventional forgings or billet stock into usable finished parts.

The cost savings resulting from elimination of expensive contour milling operations on an aileron nose rib are shown in Fig. 3. The net forging cost at 1000 units is only 67.1% of the conventional forging and 35.5% of the hogout. Savings are $21,000 and $77,000 respectively.

It is obvious from Fig. 3 that vendor tooling cost can be quite critical. It shows that an increase in vendor die costs of only $3500 from the net forging would raise the breakeven point between the net forging and conventional forging design from 66 parts to about 200 parts.

It is also quite important that the net forging be serialized into production at the earliest possible time. If vendor tools and in-plant machining fixtures for both conventional and net forgings were purchased and the net forgings then replaced the conventional forgings at a quantity of 100 parts, the net forging would not begin to pay off until more than 400 units were produced. Serialization of the net forging at 100 parts would be difficult to tolerate even if a machined billet had been chosen as the initial design since the breakeven point between the net forging and the hogout wouldn't occur until about 185 units were produced.

Fig. 4 shows comparative cumulative costs between net forging and conventional forging of a different design. Here, the breakeven point is 315 parts assuming that either design could be incorporated in the first production airplane. The effect of delaying serialization until the 100th unit moves the break even point back to 560 parts while the potential saving at 1000 parts is reduced from about $42,500 to $27,500.

As with any other production method the detail design of the net forgings can make or break the potential cost savings. In the past the conventional forging practices, configurations, and tolerances have limited the designer. The field of allowable design configurations is greatly enhanced by net forging, but care and ingenuity must be exercised by the designer to avoid complex ties that will eliminate the chance for cost savings.

The future for net forgings may be expected to represent 30% to 50% of production requirement for all forging in terms of quantity.

The trend toward larger forgings will be accelerated by the heavy presses of Alcoa and Wyman-Gordon. The Air Force, the forging manufacturers, and the airframe industry can, through coordinated development effort push the use of net type forgings. This would do much to free up contour milling equipment throughout the industry.

In addition to making better use of the heavy press program, net forgings should be adapted to materials other than aluminum and magnesium. Some alloy steels have always been used in aircraft. Titanium is beginning to find usage in airplanes. We are going to see increased use of steels in a number of high strength, difficult to machine alloys. Here the importance of reducing machining will be even greater since production rates will be more affected by machine tool capacity which, in turn, is determined by the practical metal removal rates of the equipment.

The report on which this article is based is available in full in multilith form together with reports of the 14 other panel sessions of the 1955 SAE Aircraft Production Forum. This publication, SP-313, can be obtained from SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.

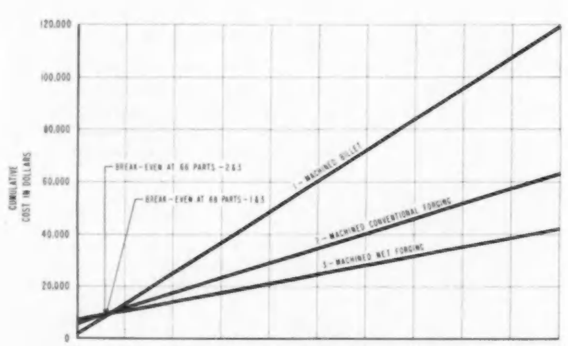


Fig. 3—The cost savings resulting from elimination of contour milling operations on an aileron nose rib by net forging are $21,000 and $77,000 respectively when compared with conventional forging and machined billet for 1000 units. Note that an increase of only $3500 from the net forging would raise the breakeven point between the net forging and conventional forging design from 66 parts to about 200 parts. These curves are based on a release quantity of 60 parts.

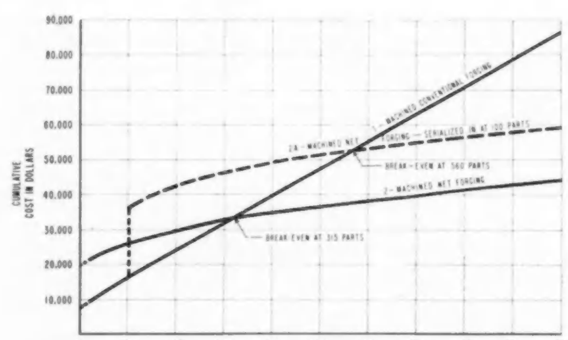


Fig. 4—This cumulative cost comparison of net forging and conventional forging is based on a release quantity of 100 parts. Here, the breakeven point is 315 parts assuming that either design could be incorporated in the first production airplane. The effect of delaying serialization until the 100th unit moves the breakeven point back to 560 parts while the potential savings at 1000 parts is reduced from about $42,500 to $27,500.

Combustion Liners . . .

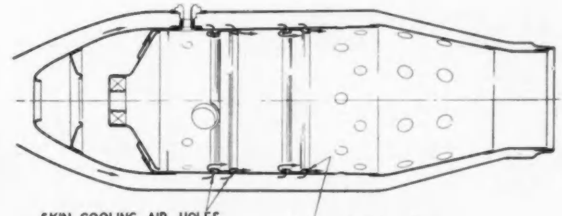


Fig. 1—To overcome buckling of the flame tubes on the Dart turboprop engine, cooling strips or rings were added to the tubes for the purpose of lowering skin temperature.

. . . *of Dart turboprop engine given double service life by skin-cooling device*

D. P. Huddie, Rolls-Royce, Ltd.

Based on paper "The Development of Rolls-Royce Propeller Turbine Engines" presented at SAE National Aeronautic Meeting, New York, April 10, 1956.

AFTER 750 hours of service life, the combustion liners or flame tubes of the Dart propeller turbine engines showed heavy buckling forward of the shoulder hole with cracking of the shoulder hole itself. A look at the wall temperatures of the flame tube made the reason fairly obvious.

Skin-cooling of the tube was tried in accordance with a suggestion made by Dr. J. S. Clarke of Messrs. Joseph Lucas, Ltd., and shown in principle in Fig. 1. The cooling rings are attached to the flame tube and cooling air enters both up and downstream of these rings through the small holes shown, with the effect on skin temperature to be seen in Fig. 2.

The original flame tube has very high temperatures upstream of the shoulder hole cooling device, and comparatively low temperatures downstream of it. This means a rigid restraining of the hot metal upstream by the cool and stiff shoulder. On the new tube, skin temperatures are lower and there is no significant temperature gradient across the cooling device. After 1230 hours in service, the new tubes were in such good condition that they were returned to service for a further 500 hours. It is now felt that they will be good for 1500 to 2000 hours without service.

The cooling strip has one basic disadvantage. It does not pick up the total lead of the cooling air, but only the static pressure. For this reason it will become less effective as combustion pressure loss is reduced progressively. However, the device has been so successful that we are experimenting by expanding the diameter of the flame tube in the region of the cooling strip to enable the cooling holes to pick up as much of the total pressure as possible.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members; 60¢ to nonmembers.

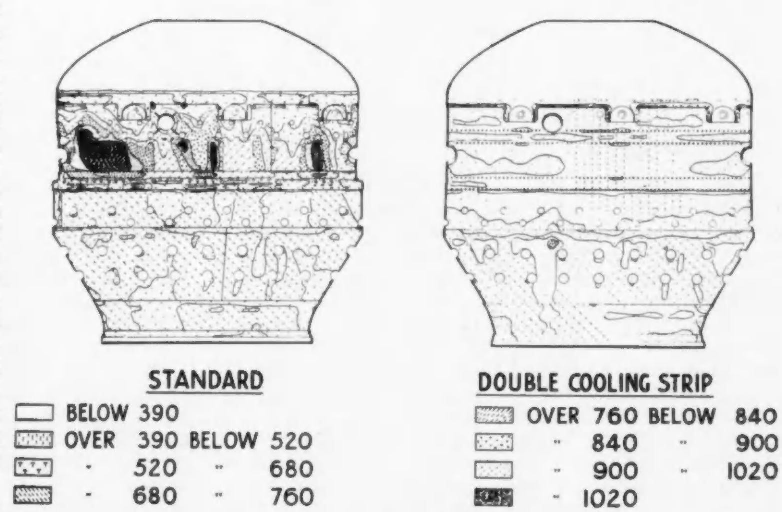


Fig. 2—Lowering of skin temperature of flame tubes on Dart engine by use of cooling rings is shown by contrast between old and new tube. Temperatures are given in degrees Centigrade.

They're Taking The Noise

NOISE reduction features now eliminate much of the noise associated with outboard motors. Exhaust and inlet noise are subdued by mufflers. Mechanical rattles are lessened by preventing resonance of any motor parts. Engine internal noise is reduced by means of sound barriers. And, "boat talk" is eliminated by a vibration isolation system.

The noise sources of an outboard motor are:

1. Exhaust noise
2. Carburetor inlet noise
3. Mechanical rattles
4. Engine internal noise
5. Boat talk

Exhaust Noise

Much exhaust noise is eliminated by passing the exhaust underwater and entraining it in the slip stream of the propeller. Although some noise emanates from the surface of the water behind the transom, this seems to be the most effective way of handling the exhaust.

Unfortunately, the 2-cycle engine driven outboard motor, as we manufacture it, requires what is called "exhaust relief" when idling. This consists of a small, above-water exhaust opening which helps the engine to idle as low as 400–500 rpm. This opening gives off noise at all speeds unless some type of muffling is provided. In addition to using a muffler, engine cooling water is passed through the relief. This aids in reducing the exhaust noise associated with idling speed.

At high speed the water pump output increases enough to effectively block off the opening and the noise.

Inlet Noise

The inlet noise for a 2-cycle engine is considerable. It is caused by pulsations of the air in the vicinity of the inlet and occurs at frequencies that are audible to the ear. These pulsations are superposed on the flow of air entering the carburetor. The problem here is to exclude the high frequencies without interfering with the steady flow of air required by the engine.

For those who are familiar with a-c electric circuits, we can simplify the problem by referring to the need for a low pass filter which passes low frequencies or direct current, but short circuits or attenuates the high frequencies. The inlet muffler shown in Fig. 1 approximates this situation and is analogous to the low pass filter.

The attenuating curve (Fig. 1) shows that the muffler will not reduce some high frequencies. This is caused by the shorter wave lengths of the high frequency sounds being small compared to the muf-

Out of Outboard Motors

James W. Mohr, Research Engineer, Outboard, Marine & Mfg. Co.

Based on paper "Noise and Vibration Reduction and Its Application to the Outboard Motor" presented before SAE Milwaukee Section, Oct. 7, 1955.

fler size. Fiber glass lining aids considerably in correcting this condition.

As in an electric filter, the relationship of capacitance and inductance determines the cut-off frequency. Since engine performance must not suffer too much, the size of the parts must be maintained sufficiently large. Since space, weight, and cost are also involved, however, a compromise has to be established. Mufflers should only be made as effective as the overall noise level established by the other noise sources warrants.

The inlet muffler on larger motors sometimes incorporates a side resonator cavity. The shape of the muffler and its electrical equivalent are shown in Fig. 2. The side cavity is tuned to reduce some of the high-intensity, low frequency noise which is a part of the total inlet noise.

Mechanical Rattles

Mechanical rattles can be a problem unless they are considered seriously. All linkages must be tightly secured. Structural elements should be stiff and there should be no possibility of resonance being excited in the parts throughout the operating speed range.

An electro-mechanical shaker aids in determining the natural frequency of any parts of a mechanism. It also helps in locating rattles. If any of the parts have natural frequencies which can be excited to resonance somewhere in the operating range of the machine, the frequencies should be changed by increasing or decreasing stiffness and/or the mass of the parts.

Engine Internal Noise

Engines generate noise within themselves. Engine internal noise can be reduced by proper design, but it will always persist. The best way to handle this problem is to decouple the noise source from the noise radiator and to put a sound barrier or enclosure around the noise source.

The sound barrier is the outboard motor cover assembly, which is also the main component of styling. The covers should be closed as completely as possible, and must be mechanically or acoustically decoupled from the noise sources, or they will serve as an efficient radiator of noise. Soft rubber mounts are usually used for supporting the covers.

If the cover openings are too many or too large, a lining of acoustical absorption material is effective in reducing noise. When there are no openings, or

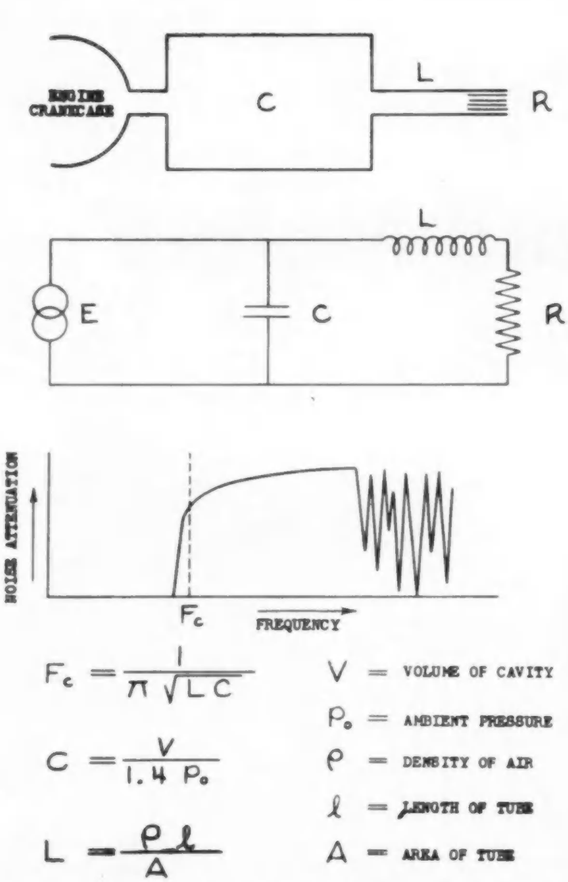


Fig. 1—The inlet muffler attenuates the high frequency pulsations superposed on the flow of air entering the carburetor of an outboard motor. This setup is analogous to the low pass electrical filter. Note from the attenuating curve that the muffler does not reduce some of the high frequencies.

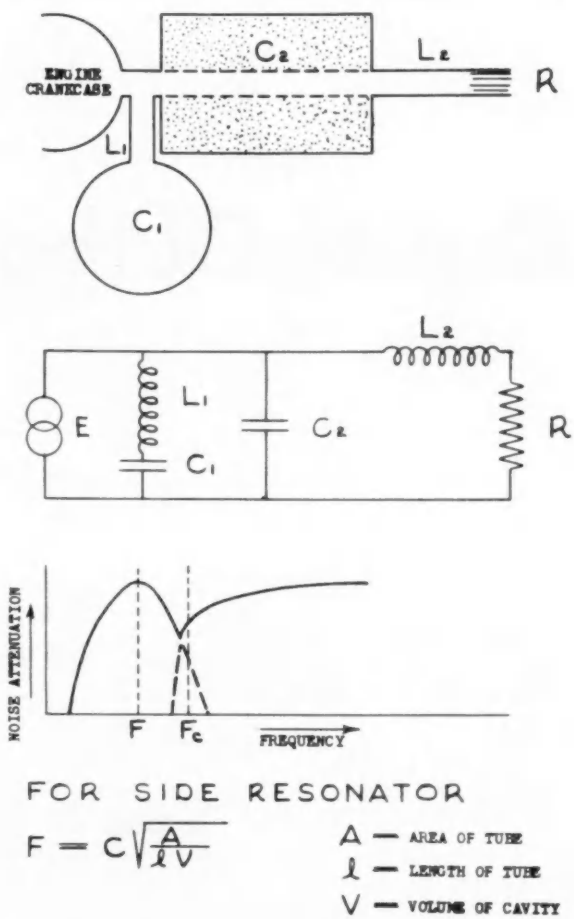


Fig. 2—The larger outboard motors sometimes incorporate, as part of the muffler system, a side resonator cavity. The side cavity is tuned to reduce some of the high-intensity, low frequency noise which is part of the total inlet noise.

when they are small, the absorption material does little or no good.

Boat Talk

The boat is a very effective acoustical radiator, so the noise source must be decoupled from it. This means that a vibration isolation system must be used. If this isolation system is effective it does away with "boat talk" and its accompanying vibration. "Boat talk" is the low frequency noise due to the boat being shaken at audible frequencies.

For a top speed of, say 5000 rpm, the maximum boat talk frequency is 167 cps, which is definitely in the audible range. "Boat talk" is that low drone that carries so far over the water.

Various factors affect the design of a suitable vibration isolation system. These are:

1. The relative magnitudes and directions of the vibration exciting forces.
2. Frequency range of the exciting forces.
3. Stability of the unit as affected by forces external to the system.

The theory of vibration isolation, however, is briefly this: The mechanism containing the vibratory forces (the engine) must be flexibly mounted so that the natural frequency of the unit and its mountings is less than the frequency of the exciting forces. A "rule of thumb" in designing an isolation system is to make the natural frequency one-third that of the lowest exciting frequency, if possible. Reduction of vibratory forces transmitted will begin when the exciting frequency is 1.4 times greater than the natural frequency, and the transmitted force will continue to increase as the exciting frequency increases.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

Biological Research Yields Specific Data as

AIDS TO VEHICLE DESIGN

Dr. Ross A. McFarland, Harvard School of Public Health

Excerpts from paper "Human Factors in Highway Transport Safety" presented at SAE National Transportation Meeting, St. Louis, Mo., Nov. 2, 1955.

BIOLOGICAL and engineering sciences can collaborate effectively to design cars and trucks in terms of human capabilities and limitations. The automobile should be built around the operator rather than placing him in a setting without due regard to his requirements and capacities. Such integration of the driver with his vehicle is one important way to improve highway safety.

Extensive research has already revealed many constructive design helps in these major areas in which engineers and biological scientists can work together:

(a) Layout of the driver's area for comfort and efficiency of operation, including allowances for variations in human body size;
(b) Design and arrangement of controls;
(c) Design and arrangement of visual displays to provide information for operating under normal emergency conditions;
(d) Driver protection against sudden deceleration or collision;
(e) Control of toxic factors in the environment.

Designing the Driver's Area

In general, any control unnecessarily difficult to reach and operate; any instrument difficult to read; any seat inducing poor posture or discomfort; or any unnecessary obstruction to vision may contribute directly to an accident . . . because of the difficulty of proper operation on the part of the driver.

To determine the minimum size of a vehicle seat, for instance, and the effective location of controls, pedals, and switches, it is necessary first to determine the full range of size of the driving population.

Once this has been established, by anthropomorphic techniques, the equipment may be evaluated in terms of the following sort of questions:

> "Is there sufficient horizontal adjustment in the seat so that a small woman can reach the pedals and still give a tall man enough space so that his legs won't be cramped under the steering wheel?"
>
> "Is there sufficient vertical adjustment in the seat to allow the short woman to have her eye-level several inches above the top of the steering wheel, and still permit the tall man to bring his eye-level below the top of the windshield?"
>
> "Are all controls within easy reach of the driver, once the seat has been adjusted?"
>
> "Is the inside of the car or cab high enough so that the tall driver can avoid striking his head on the roof?"

If answers to these conditions are unsatisfactory, the equipment is poorly adjusted to the extremes of the size distribution of drivers.

Lack of horizontal seat adjustability will force the short driver to sit forward on the seat with no

The paper from which this article is drawn plus two other articles by Dr. McFarland appear in full in the 1956 SAE Transactions . . . which has just been mailed to subscribers.

The other two papers are "Human and Environmental Factors of Automobile Safety," presented at SAE Summer Meeting, Atlantic City, N.J., June 16, 1955, and "Human Problems in Jet Air Transportation," presented at SAE National Aeronautic Meeting, New York, N.Y., April 18, 1955.

brace for her back, and she may have trouble in steering or applying the brakes. Moreover, without adequate vertical adjustment, she will have a limited field of vision and thus will have difficulty in seeing people or objects close to the vehicle.

Inadequate vertical and/or horizontal seat adjustment for the tall man may cause him to strike the steering wheel when moving his leg to the brake. It may thus prevent him from braking in time. An accident may occur when a control is so far from the driver that he must lean out of the normal driving position to operate it.

The measurements of the human body necessary for establishing the dimensions of the working space and locating controls have been outlined by B. S. King as follows:

(a) Maximum arm reaches attainable without altering the position of the body.
(b) Extension of these reaches which can be attained by the movement of the trunk or body.
(c) Eye level of the man in the operating position.
(d) Body dimensions in the operating position . . . that is, sitting heights, fore-and-aft lateral measurements at various levels.
(e) Leg reaches attainable without altering or disrupting posture.

With such information available, the engineer can design to accommodate a very large percentage of the driving population with regard to comfort and efficiency and safety.

Designing Controls and Displays

Important factors in design and operation of controls are:

- Location for ease and accuracy of reaching;
- Direction of movement for greatest efficiency;
- Force which must be applied for operation;
- Rate of movement from point to point;
- Speed and amount of rotary or wrist movement required in wheels and knobs;
- Size and shape;
- Frequency of use;
- Degree to which the control performs a critical function.

Much data of this nature is currently available and may be applied to the problems of automotive design.

Recent changes in the pedal design of some cars, for example, have considerably reduced the foot travel distance. This improves the condition sometimes occurring when brake and accelerator pedals are so placed as to force the driver's foot to make lengthy movements in three directions before the brake can be activated.

Visual displays also can contribute directly to troublesome situations if an operator does not clearly perceive the location or movement of the indicators or dials.

Factors having a significant effect on ease of instrument reading include size and spacing of critical detail, contrast between object and immediate background, amount of illumination (including the use of color), and contrast between the objects to be seen and their surroundings. Design criteria for the shape, size, scale markings, and numbering of instruments, as well as the most legible width and length of pointers, have been determined experimentally and are currently available.

Improvements in positioning and visibility of specific instruments and controls may save the driver only one-tenth of a second in some emergency situation. At 40 miles an hour, however, one-tenth of a second means 6 ft . . . and 6 ft means the difference between life and death to a driver in a critical situation.

What Humans Can Withstand

A human being can withstand very high accelerative forces, without injury, if he is properly restrained. On the other hand a speed of fifteen miles per hour can cause death if the momentum of the head is not checked during rapid deceleration of the vehicle.

If a 10-lb object, the approximate weight of a human skull, falls one foot and strikes an area one inch square the deformation would be very slight. On the other hand, under the same conditions, if an object one centimeter square is struck, a puncture fracture would result.

An interesting sidelight on crash injury data from two different studies: In at least two instances, attempts to commit suicide by driving head-on at high speed into an embankment or a wall were rendered ineffective because design of the steering-wheels and steering posts were such that impact forces were absorbed through deformation and were dissipated over relatively wide areas, so that serious injury was prevented.

Protection on Toxic Factors

The comfort, efficiency and safety of the driver are also influenced by the extent to which design features in the car are able to modify or control the physical variables of the environment. These variables include temperature, humidity, ventilation, carbon monoxide, noise, vibration, and deceleration. For each of these factors there are reasonably well defined ranges of comfort, discomfort, and harmfulness.

Heat, Humidity and Ventilation

Temperature, humidity, and ventilation must be considered as a unit. Any change in one will affect the other two insofar as they determine comfort.

Winter comfort zones range from a dry bulb temperature of approximately 65F to 78F, and summer from 68F to 85F, depending on the relative humidity. The optimum range for winter is 68F to 72F (dry bulb) . . . and for summer 74 F to 78F. For these comfort zones a relative humidity of 30 to 70% is quite acceptable.

But air movement and freshness is important, too. Very low rates of air movement will produce a feeling of stuffiness.

Optimally 35 to 40 cfm of fresh air should be supplied per individual at velocities of between 20 and 60 fpm to maintain a sense of freshness without creating undesirable drafts. (Air velocities tend to have a greater cooling effect which may be advantageous in summer but uncomfortable in winter.)

The most important implication of the atmos-

pheric variables is that human performance has been shown to deteriorate at temperatures of about 83F combined with 100% humidity.

Many of these atmospheric variables have been controlled in modern motor vehicles by use of adequate heating, air conditioning, and ventilating equipment. This insures, not only increased comfort and efficiency for the driver, but also the likelihood of a small attendant decrease in accidents resulting from deterioration in driver performance and skill.

Designing Against Carbon Monoxide

Exhaust systems of modern motor vehicles, in general, have been made resistant to the loss or leakage of fumes. (But truck drivers should be well indoctrinated into the procedures of airing vehicles left standing with idling motors. The possibility of carbon monoxide poisoning can rarely be completely eliminated in the operation of motor vehicles.)

Dangerous concentrations of carbon monoxide may result from leaks in the exhaust system. (Use of a carbon monoxide tester will easily reveal whether levels in any given case are in the danger zone.)

Exposure to even as small a concentration as 0.01%, although having no perceptible effects for several hours, should not be permitted over long periods of time.

Controlling Noise and Vibration

Noise and vibration levels in most passenger automobiles are of a sufficiently low degree to require virtually no design changes from the point of view of drive health and safety.

This is in marked contrast to the situation of some commercial vehicles where overall sound level readings of as much as 95 decibels have been recorded. This figure is within or approaching the limits for hearing loss set by some investigators.

Noise reduction in commercial vehicles constitutes a real challenge to automotive engineers.

The most satisfactory criteria for comfort in regard to noise levels is the ease at which ordinary conversation can be carried on without exerting great effort.

Engineer-Scientist Collaboration

There are many effective ways in which engineers and biological scientists may collaborate to the benefit of the vehicle driver, as cited examples of research results indicate. Mechanical design should be based on the biological and psychological characteristics of the drivers, and vehicles should, therefore, be designed from the man outward with instruments and controls considered as extensions of his nervous system and body appendages.

Only by advance analysis can all possible faults in the machine be anticipated and avoided before the vehicle is put into production. This can be done only in conjunction with an operational job analysis . . . a functional concept of accidents . . . an awareness of human limitations . . . and the provision of a wide margin of safety.

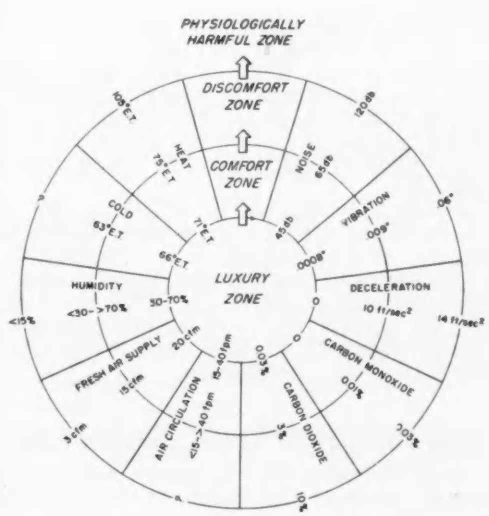
VARIOUS STIMULI ENCOUNTERED IN DRIVING are schematically interpreted below in terms of limits for comfort, discomfort, and physiologically harmful zones.

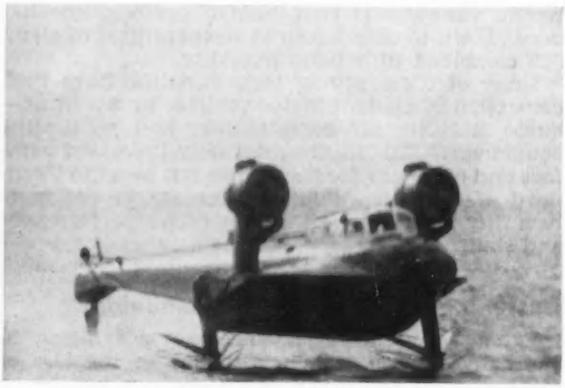
The values indicated cannot always be considered as rigid standards because of the interdependence of one variable with another.

The difficulty of giving a single numerical value as a standard is exemplified in the limits for carbon monoxide. The generally accepted maximum value is 100 ppm of carbon monoxide in circulating air for prolonged exposures. This figure may be satisfactory for a person sitting quietly at sea level, but it should be reduced if the amount of exercise, degree of ventilation, or the length of time increases.

The permissible amplitudes for vibration, on the other hand, apply only at frequencies of 8 cps or less. Frequencies higher than this are probably not a major factor in automobile operation.

The same complexity characterizes almost every other function. Linear scales or straight line functions are not so adaptable to the study of human variables as nomograms in which one can ascertain the effects of altering any one of the variables upon the others.





WITH AREA-STABILIZED HYDROFOIL, height of the craft above the water surface is steadied by varying amount of foil immersed in water. As the foil enters a wave, more of the foil is immersed, and thus additional lift is developed to raise the hull over the wave. Variable area can be achieved by V-type foils shown at left on 24-ft experimental "High Pockets." Or it can be achieved by a ladder-like series of foils such as the two sets faintly visible on the airscrew-driven hydrofoil craft shown at the right. Area-stabilized foils are inherently stable. However, a significant portion of the foil is out of use, most of the time.

Hydrofoil Craft: Boats

Lt.-Com. Robert E. Apple, USN, Hydrofoil Project Officer
Office of Naval Research

Based on paper "Hydrofoil Craft: Present Status and the Central Problems" presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 3, 1955.

HYDROFOIL boats are both feasible and advantageous.

A hydrofoil passing through water develops lift just as an airfoil passing through air does. (Since a significant portion of the lift developed by either type of foil comes from the negative pressure due to flow of fluid over the convex surface of the foil, hydrofoil action is considerably different from planing action in which only the lower surface is submerged.)

The Navy's experience in operating the craft shown above and other research craft has definitely established the practicability of hydrofoil craft. The experimental program has made possible the evolution of design procedures to the point where they can be incorporated into handbooks that allow the naval architect to design small craft, up to about 50 tons, with confidence.

Low Drag, High Speed, Smooth Ride

Since a hydrofoil boat proceeds with the hull completely clear of the water, its drag is greatly reduced. As a result, a hydrofoil craft can attain the same speed as a similar displacement boat, with as little as half the horsepower of the displacement boat. This statement assumes the displacement craft has a relatively large speed/length ratio as, for example, crash boats or PT boats.

If it is desired to use the hydrofoil advantage to obtain added speed, the speed can be increased by as much as 80%, with no increase in horsepower. The craft High Pockets illustrated above attains a speed of 20 knots as a displacement boat powered by a 125 hp Chrysler Crown engine. As a hydrofoil boat, it can attain a speed of 36 knots. Furthermore, this craft on hydrofoils can make 32 knots in waves as high as 4 ft.

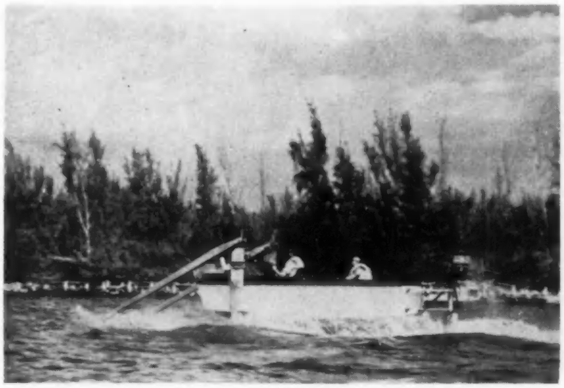
This illustrates the other primary advantage of hydrofoil boats: Their speed and riding qualities are vastly superior in rough water to those of either a displacement or planing craft. High Pockets has outrun a 63-ft air-sea rescue boat, with the same rated speed, in 5-ft swells of the open ocean off Pensacola, Florida. A 25-knot 40-ft air-sea rescue boat could not stay with the 25-knot 16-ft Hook configuration hydrofoil boat shown above in a bad 4-ft chop off Miami Beach.

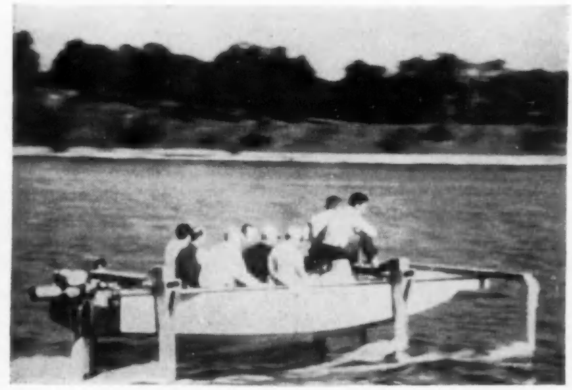
Some of the other advantages of hydrofoil craft are:

A negligible wake, even at extremely high speeds;

Little craft motion when lying-to in rough water, due to the damping action of the foils;

Shallow draft when flying.





INCIDENCE-CONTROLLED CONFIGURATION known as Hook type shown above at left has submerged foils fore and aft and two planing skids forward of the bow. Skids tilt forward foils through mechanical or hydraulic linkages. Craft at right uses electrical sensors instead of planing skids. As water level rises on the two forward struts, additional resistances are shorted out. Signal is sent to step-by-step servos which position forward foils. Aft foil can be fixed or controllable. Grundberg type of incidence-controlled craft has one fixed foil aft and planing skid forward. As skid rises with a wave, it changes lift of foil.

that Fly on Wet Wings

Hydrofoil craft also have some inherent disadvantages. The two principal ones are the increased cost and the complexity of foils for small boats. It is still not possible to state how serious these factors are since very little operational experience is available and also hydrofoil craft as yet have not been mass produced.

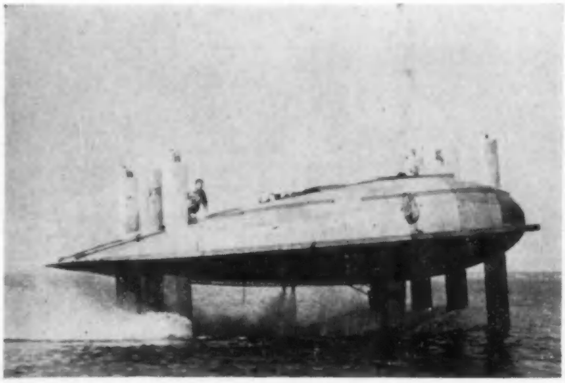
One possible disadvantage which has been foreseen, but which has not yet materialized, is the hazard of the foils hitting an object in the water. If a large timber or other large object were hit, the foil would fold back and cause the boat to brake abruptly, it was reasoned. During the Navy's test programs, however, one craft was run aground at full speed without injury to the crew or boat. During one test, the high-speed ladder-foil equipped craft shown above inadvertently entered an ice field approximately 1-in. thick at 65 mph but was able to complete a turn and withdraw without mishap.

Night operations at high speeds in cluttered waters would undoubtedly be difficult.

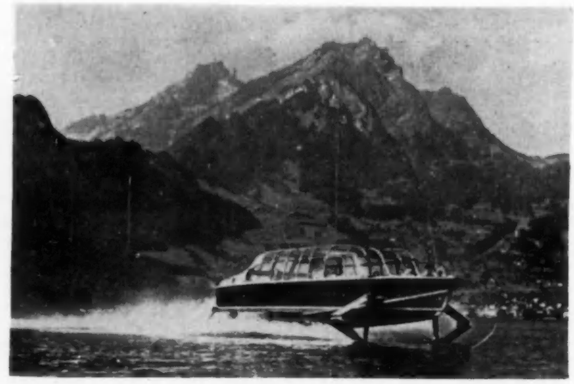
Although small craft can now be designed with confidence, several major areas still require intensive investigation. Powerplants and transmissions constitute a particularly weak spot, and an extensive development effort, perhaps on a national scale, would be required if the need arose for large-scale production of hydrofoil craft. Since hydrofoils develop dynamic lift in a manner similar to airfoils, the initial weight of the craft is as critical as in an airplane. Yet the development efforts in light-weight marine engines have been nowhere near as intensive as have those for aircraft engines. Gasoline engines are sufficiently light to allow a good payload for small craft but present a much greater fire hazard than do those using the less volatile diesel fuels. The gas turbine is one promising development which should contribute to the solution of the engine problem for hydrofoils.

Transmissions are closely allied to the problem of light-weight powerplants. Hydrofoil craft present the unique difficulty of transmitting power from the hull through a relatively long distance into the water. The transmissions now being used are of four general types: (1) V drives through a long inclined shaft, (2) a right angle over the stern, (3) high velocity chain drives through a V strut, and (4) air-screw drives. An air-screw drive might be considered a solution to both the weight and transmission problems. A number of considerations combine to prevent this from being a full answer to the problem, however. Among the chief difficulties are low efficiencies at low speeds and hazards to the crew.

Another broad area which requires additional effort is scaling from small model to large craft, especially the scaling of ventilation, cavitation and seaworthiness. Ventilation is the phenomenon of drawing air down the upper, suction, side of a surface-piercing foil. Several methods are now used to inhibit this. One method, widely used in Germany, is to place dams, called "fences," on the



HYDROFOILS OF THIS CRAFT are controlled by a modified Sperry A-12 automatic pilot which corrects for motion of the craft. Altimeter is a hydrostatic diaphragm well beneath surface of the water.



10-TON, 30-PASSENGER HYDROFOIL BOAT has been operating on Lake Maggiore in Switzerland. Boat was built by German-Swiss firm Supramar A.G. It gives fast, smooth ride.

foils. These are thin sheets of metal running chordwise placed at intervals along the foil. In this country ventilation is avoided by carefully choosing foil sections with essentially flat pressure distributions, by using high dihedral on the foil, and by sweeping the foil aft to create a spanwise flow.

Although there has been good success in prohibiting ventilation there has not been equal success in predicting the onset of ventilation when the foil is scaled up. The onset of cavitation also is difficult to predict; however, the scaling of model experiments is fairly reliable.

The scaling of seaworthiness must receive additional attention as larger craft are built. A characteristic parameter which relates lateral stability to the design configuration must be established. Also the limiting wave conditions in which a craft is still capable of sustained flight can not now be positively predicted from model tests. For example, while High Pockets can successfully fly 32 knots in 4-ft waves, it is not known what are the highest waves in which geometrically similar craft twice this size could fly.

Besides powerplants and transmissions, and scaling, additional theoretical and experimental investigations must be conducted on the influence of the water-air interface, in view of the fact that the hydrofoil craft operates very close to the interface of two media.

As an example, the altitude limitations are very severe. An error of 1 ft in altitude might mean that the boat would broach or crash. Also, as the foil approaches this interface, which is the surface of the water, both the lift and drag change and the center of pressure shifts.

Another complexity which arises from flying near the surface is due to the orbital velocities of the waves. In an ahead sea they tend to help in that they assist in developing additional lift when it is required to lift over a wave. However, in a following sea the orbital velocities are opposite and tend to decrease the lift when it is desired to develop additional lift over a wave. Also these orbital velocities are not large-area disturbances such as air gusts but are local perturbations at each foil. Therefore, each foil must cope with its own immediate surroundings.

Ideally a foil should continuously align itself to the orbital flow for steady flight with superimposed angle changes when changing lift.

One question which is nearly always asked is, "How large a hydrofoil boat can be built?" It is still not possible to give a definite answer to this question at the present stage of hydrofoil development. Some insight into the problem can be gained from realizing that the weight of a hull varies approximately as the cube of a linear dimension, but the equation for the lift of a foil relates lift to the square of a foil linear dimension. Therefore, foil size grows disproportionately with boat size. (This assumes that velocity remains constant.) This illustrates the fact that a hydrofoil craft loses much of its advantage over displacement craft if the speed, or more specifically, the speed/length ratio, is not also scaled. A 1000-ton craft would probably have to have a speed requirement of more than 50 knots—to be more desirable from a power consideration than a displacement craft of similar size.

The largest craft built to date was an 85-ton tank-carrier built by the Germans during World War II. It ran aground before a complete evaluation was made. The size is probably indicative of present capabilities. It would be necessary to gain experience in the 100-ton size range before proceeding to larger sizes.

There are numerous possibilities—both naval and commercial—for application of hydrofoils. A 10-ton, 30-passenger hydrofoil craft built by a German-Swiss firm has been operating on Lake Maggiore in Switzerland. The Nautic concern of Bremen has built a 20-ton, 70-passenger boat for operation on Lake Constance, also in Switzerland. Three hydrofoil police boats have been procured by the French Rhine patrol and the Hessian water police. American firms, too, have shown an interest in commercial production.

The opinions and assertions contained herein are those of the writer and should not be construed as being official or reflecting the view of the United States Navy.

Glimpses of the DC-8

Gordon Farquhar, Assistant Chief Project Engineer, Douglas Aircraft Co.

Based on talk presented before SAE Metropolitan Section, New York, May 10, 1956, as reported by Henry Wakeland, field editor.

ENGINES First DC-8's will be equipped with Pratt and Whitney Aircraft JT-3 turbojets (similar to military J57 jets). Deliveries of certified aircraft will start by the fall of 1959. Higher thrust P&WA JT-4's will go into an overseas version of the DC-8 scheduled for delivery in 1960. Conway bypass-type turbine powerplants by Rolls-Royce will power DC-8's bought by Trans-Canada Air Lines.

With the JT-3 engines, block times with average winds will be:

Block	Time Hr:Min	Speed and Direction of wind
New York-Chicago	1:45	50-knot head wind
New York-Washington	0:42	43 " " "
New York-Miami	2:21	22 " " "
New York-Los Angeles	5:09	50 " " "
Los Angeles-New York	4:17	50 " tail wind

With JT-4 engines, block times with average winds will be:

Block	Time Hr:Min	Speed and Direction of wind
New York-London	6:24	26-knot tail wind
New York-Paris	6:45	26 " " "
New York-Los Angeles-Honolulu	10:27	50 " head wind

The DC-8 will include a thrust reverser. Reverse thrust is guaranteed to be at least 40% of engine forward thrust.

JET NOISE AND BLAST Noise problems which have been expected with jet transports will be minimized by the use of a "selectable" noise suppressor which reduces the sound level about 10 db while reducing thrust only about 1%.

The wind blast felt by ground personnel during ground maneuvers of the jet transport will not be any stronger than that of the DC-7 under compatible conditions. Hot exhaust gas from the jet engines will be cool enough to be harmless by the time it passes the tail of the aircraft.

COMPRESSOR BLEED AIR POWER Hot compressed air from the engines is used for anti-icing, de-icing, and operation of the cabin superchargers. The aircraft contains ductwork for distribution of this air from the engines. The nose of the airplane and leading edges of the wings and tail all are deiced by hot air brought from the engine compressor.

Engines are also started by the power of compressed air. The first engine to be started draws air from a ground source or self-sufficient starter. Then the other engines make use of the air provided by the first engine.

Electric power is provided by alternators using the Sundstrand alternator drive. The electrical system can provide enough power to light 368 average city homes.

CONTINUED ON NEXT PAGE

WINGS NACA, British and Douglas research efforts have been used to develop the most advanced swept wing possible. Blending of requirements for high cruise Mach number, high lift for take-off and landing, light weight, and excellent high and low speed handling qualities led to new airfoil developments and 30 deg sweep angle.

CONTROLS The elevator is manually operated and an adjustable stabilizer is provided. The rudder is power operated to provide crosswind landing characteristics comparable to those of current aircraft. Normal ailerons located slightly inboard of the wing tip provide the required control from stall speed to dive speed. They are power operated.

LANDING GEAR The main landing gear is of the dual tandem type. It folds inward. There will be four wheels on each main gear and two nose wheels. The dual tandem main gear (two wheels in front of strut, two behind) was chosen to reduce loads on airport pavements. The dual tandem gear can be de-linked to allow sharp turns on the ground. Nose wheel steering is normally used.

WEIGHTS The gross weight of the DC-8 is roughly twice that of the 140,000 lb DC-7C. Here are the weight figures for the two versions of the DC-8:

	Domestic Version	Overwater Version
Max. Gross Weight	265,000 lb	287,500 lb
Max. Landing Weight	189,000 lb	190,500 lb
Max. Zero Fuel Weight	165,000 lb	167,500 lb
Manufacturer's Weight Empty	118,265 lb	120,737 lb
Fuel Capacity	114,400 lb 17,600 gal	140,500 lb 21,615 gal
Space-Limited Payload	37,910 lb	37,910 lb

COCKPIT One set of engine throttles serves both pilot and copilot. The flight engineer is seated to the rear of the copilot and faces either forward or to the right. His responsibilities include the management of the fuel system, electrical system, and cabin air supply.

The CAA windshield requirements require resistance to the impact of a 4 lb duck striking at cruising speed. When this requirement is added to the high internal pressure and the de-icing requirements, the resulting six-layer windshield becomes 2½ in. thick.

The windshield has two laminated panes with an air space between. Each pane is laminated of two layers of glass and a layer of non-shattering vinyl plastic. One of the two layers in each pane is of NESA electrical-conducting glass. (NESA glass is heated by passage of an electric current to prevent icing of the windshield on the outside and fogging on the inside.) A layer of hot air piped from the engines also sweeps the outside of the windshield to disperse water droplets. Mechanical windshield wipers are not expected to be necessary.

SEATING The new airplane will be both larger and heavier than the DC-7. There are several possible seating arrangements which utilize the larger floor space. In a tourist class version, 144 passengers are seated six abreast. There are four seats 19¾ in. wide, two seats 19 in. wide, and a 16-in. aisle. A five-abreast version carries 118 seats and a lounge with 22-in. seats and a 20¾-in. aisle. In a four-abreast model, intended mostly for berth arrangements, the seats are 23½ in. wide, with a 35-in. aisle.

Twin class arrangements are standard arrangements. A movable bulkhead between sections allows the ratios between classes to be altered.

CABIN COMFORT The cabin will be pressurized to a 6700 ft level when the DC-8 is at 40,000 ft. Cabin windows will have three panes. Either of the two outer panes take the pressure load. An inner pane provides an acoustic barrier. The windows will withstand a pressure eight times that imposed by the pressure differential at maximum altitude.

Radiant panels at the sides of the cabin will provide heat to the cabin. Ventilating air is pressurized and circulated through the cabin by four cabin superchargers. Any one supercharger can provide full pressure at a somewhat reduced circulation. Air enters the cabin near the top of the side wall and is discharged near the floor around the cargo compartments below.

The large number of passengers carried will require the DC-8 to have two galleys to speed food handling. Flushing type toilets are under study.

FUELING Fueling will be facilitated by four underwing fuel ports, located between the engines on both sides. The valves for these ports are electrically operated and can handle 1200 gal of fuel per min. at an expected fuel pressure of about 35 psi. Higher pressures will speed flow, but will not influence the safe operation of the valves. Overwing fuel arrangements are retained for use at airports not equipped with underwing facilities.

The fuel tanks themselves are of the integral type in which the walls of the tank form a part of the aircraft structure. The DC-8 will have four main fuel tanks, four alternate, and one auxiliary tank. Each main fuel tank is connected directly to its respective engine.

GROUND HANDLING The DC-8 will have two doors, one fore and one aft. Each door will be 34½ in. wide and 72 in. high.

Thorough training of personnel will allow attainment of a 30 min turn-around time, Douglas believes. This goal should be reached without any overlap between fueling time and passenger movements.

Cargo and luggage handling will be made easier and faster by the near stand-up height of the cargo space under the cabin floor. The double-circle cross-section of the airplane allows a 62-in. height in the cargo space and a 100-in. height in the cabin. Radii of the two sections are 68.7 in. and 73.5 in., respectively.

Balance of Variables Boosts Mechanical Octanes

J. M. Chandler and O. Enoch, Ford Motor Co.

Excerpts from paper "Once More About Mechanical Octanes" presented at the 1956 SAE Annual Meeting, Detroit, Jan. 12, 1956.

PROPER balance of the many variables involved in development of mechanical octanes can lead to improved performance with an overall gain in utilization of fuel. More power and economy can be obtained with a given fuel quality by combining the inherent advantages of higher compression ratios with the mechanical octane advantages of combustion chamber design, spark retarding, and mixture richening. Such balancing will permit knock-free operation at higher compression ratios on commercial fuels.

Combustion Chamber Effects

Performance characteristics of four experimental combustion chamber types at 9.0:1 compression ratio gives an interesting example for interpretive study as regards some of these "balance" factors.

The top row of curves in Fig. 1 shows knock unlimited maximum power (MBT-minimum spark advance for best torque) and knock limited power at borderline knock spark settings for a test fuel (fuel A) representing a premium grade commercial fuel. Spark advance curves for the above two power settings comprise the middle row. The bottom row shows the maximum power (MBT) octane requirement and the engine rating (in octane numbers) of fuel A. All data are plotted versus engine speed from 800 to 2000 rpm at approximately 13:1 air-fuel ratio. (The CFR engine octane ratings for the test fuels referred to in this paper will be found in Table 1.)

Power data are plotted in per cent, with the MBT power curve of Chamber 1 arbitrarily set at 100%. Since maximum power for all four chambers is practically equal at each speed, all MBT power curves show as 100%. The knock limited power of the four chambers varies considerably, however, among the four combustion chamber designs.

What makes these combustion chambers differ so much in performance? The complete answer to this question will take much more research.

But we can find part of the answer by looking closely at the test data: all of the chambers require spark retarding to bring the octane requirement down to the borderline (BL) knock level of test fuel A. Accordingly, we would expect the combustion chamber with the highest octane requirement to show the lowest knock limited power on fuel A, and so forth. Thus, we would expect knock limited power in the order of Chambers II, I, III, and IV going from low to high. Actually, Chamber II shows higher knock limited power than Chamber I, while Chambers III and IV are approximately equal.

One reason for higher knock limited power in Chamber II seems to lie in the fact that Chamber II rates fuel A much higher than does Chamber I, or in other words, is less severe than Chamber I. Therefore, less spark retarding is required in order to lower the octane requirement to the borderline knock level of fuel A, with the result of less power

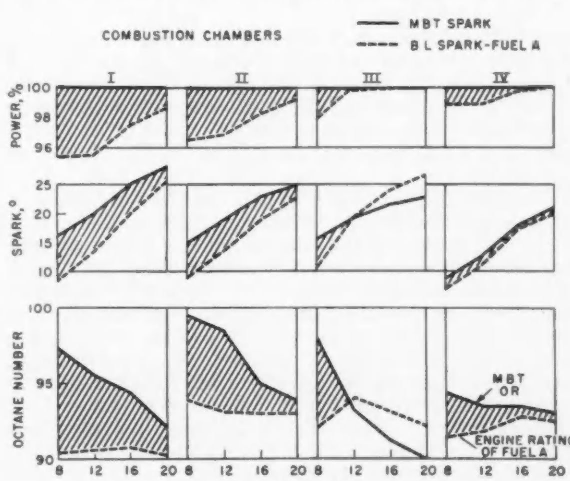


Fig. 1

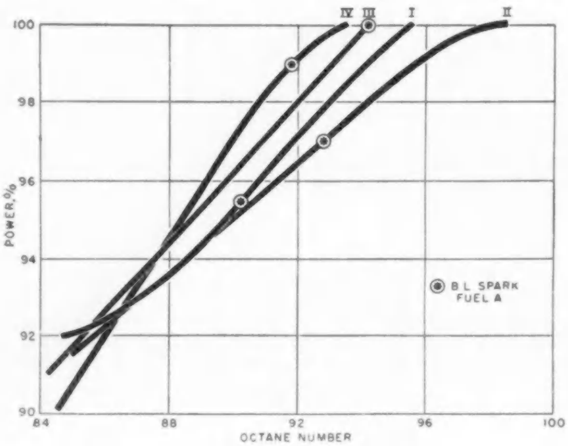


Fig. 2

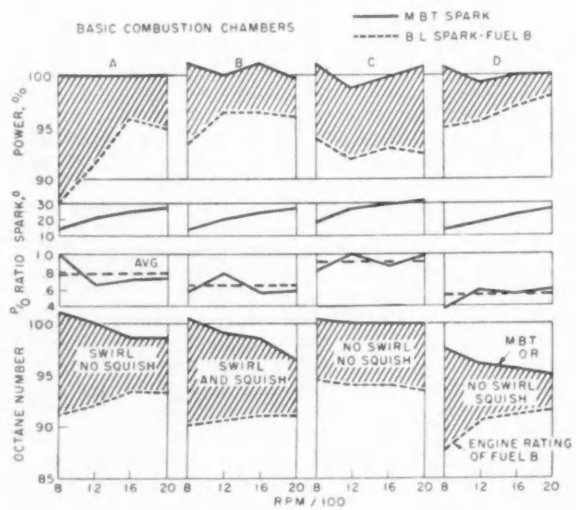


Fig. 3

loss. The same reasoning can be applied to Chambers III and IV, which show equal knock limited power curves in spite of the higher octane requirement of Chamber IV. In this case, the higher engine rating of fuel A in Chamber III might compensate for the higher MBT octane requirement of that chamber.

Another reason might be seen in the difference in power loss encountered when retarding the spark.

In Fig. 2 are plotted the power loss versus octane requirement curves which were obtained when the spark was retarded from MBT. For this example, data were obtained at 1200 rpm engine speed. The steeper the slope of these curves, the greater the power loss per octane requirement or mechanical octane number increment. We define per cent power loss per unit reduction in octane requirement as "power-octane ratio." The MBT power points in the curves are shown as 100%. The corresponding abscissae represent the MBT octane requirements of the chambers. We see that Chamber II as mentioned before, has higher MBT octane requirement than Chamber 1, and, as might be expected, less knock limited power on fuels of a constant octane rating (for instance, 92 ON primary reference fuel as shown by the 92 octane number abscissa). However, the slopes of curves for Chambers I and II differ. At the approximate 90 ON abscissa they meet, indicating that knock limited power on a 90 ON fuel is the same for both chambers. Since Chamber II, in addition to its lower power-octane ratio, also rates fuel A higher than does Chamber I, knock limited power on fuel A is higher in Chamber II than in Chamber I.

The slopes of the power-octane (P/O) curves of Chambers III and IV do not differ very much within the range of the fuel A octane ratings. Thus, the difference in MBT octane requirement still would result in lower knock limited power for fuels of constant octane rating. However, Chamber III rates fuel A so much higher than does Chamber IV that instead of a power loss, a power gain results.

At this point, a few remarks might be in order on fuel octane ratings in general. Usually the fuel we want to rate in an engine on the road or on the dynamometer is not at the borderline knock point at the operating conditions for which the rating is desired.

In order to bring the fuel to the borderline knock point, we retard or advance the spark from its normal setting. When we do this, however, we change the end-gas pressure-temperature condition, or "severity," of the engine. We must then expect that the octane rating of the test fuel might be different from its octane rating at normal spark. In evaluating octane "surplus" or "deficiency" in our engine, we have to take into account this possible difference.

We can obtain true octane rating for a given operating condition, including a given spark setting, only if the fuel to be rated happens to be at the borderline knock point at that condition.

Why octane requirements, fuel ratings, and power-octane ratios differ so much in different combustion chambers will require much more study. Some data pertaining to this question are shown in Fig. 3. It shows performance characteristics of four basic combustion chamber configurations at 9.0:1 compression ratio. All are of plain disk shape with vertical valves in series overhead. Chambers A and B have the intake flow entering tangentially to the cylinder circumference, thus representing swirl chambers. In Chambers C and D the intake flow is directed toward the cylinder center, thus representing swirl-less chambers. Chambers B and D, in addition, have 29% piston coverage, representing quench or squish. The quench clearance is 0.070 inch, and the spark plug is centrally located.

The following conclusions may be drawn from these test results:

1. MBT power is approximately equal for all chambers.
2. Both squish chambers (Chambers B and D) have higher knock limited power on fuel A, lower MBT octane requirements, lower power octane ratios, but also lower fuel ratings than the no-squish chambers.
3. Swirl introduced in the no-squish chamber has no significant effect.
4. Swirl added in the squish chamber reduces knock limited power and increases MBT octane requirement and power-octane ratio; in other words, is not advantageous.

From the above conclusions, it appears that swirl as introduced in these chambers does not have as much effect on chamber performance as does squish. In addition, swirl reduces the performance of the squish chamber.

While this test does not show sufficient data to prove or disprove the merits of squish or swirl, it does show the wide effects on engine performance of combustion chamber design.

Tests relating to other variables involved in development of mechanical octanes gave many interesting indications. In one test, for example, exhaust gas was inducted into the intake manifold, and mechanical octanes were obtained with some power loss. Power-octane ratios under some conditions, were not much lower than those obtained by retarding the spark.

Another test showed, however, that the octane requirement does not change significantly when exhaust gas dilution is increased by increasing the exhaust back pressure.

Other tests indicated that—to get optimum "balance"—it is advisable to avoid excessive carburetor air temperatures. At high compression ratios, octane requirement increases rapidly with the temperature as would be expected. However, it increases less and less as the compression ratio is lowered. Density, in other words, apparently can have the prevailing effect on knock tendency under some conditions—although, in general, knock tendency increases with increased intake charge temperature.

Still other tests indicate that by supercharging much more knock-limited power can be gained for commercial fuels than by increasing compression ratio—but with no increase in thermal efficiency.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members 60¢ to nonmembers.

Indirect Costs . . .

. . . warrant a broad attack. Efforts at reduction will yield far greater returns than whittling away at direct costs.

Based on report by **R. C. Mortensen**, American Motors Corp.

WITH refinement of controls over direct manufacturing costs, the outlay for supervision has risen. The more automatic production becomes, the more the situation is aggravated. More attention will now have to be focused on reducing indirect costs. There are four good ways to do it:

1. Establish budgetary controls.
2. Improve control of scrap, salvage, and utilities.
3. Stress good plant design.
4. Get better supervision of non-productive departments.

Budgetary controls are essential. They can be applied quickly and easily in indirect areas if responsible management personnel will forecast requirements for manpower and supplies with the intention of comparing the forecast with actual usage.

The initial budget need not be elaborate. As the data are used it can be refined to highlight significant items while useless items can be dropped. In time the data will serve as a measure of operating efficiency and provide a basis for estimating the relationship of budgetary items to production requirements.

Scrap and re-work problems are usually blamed on the foreman, but there are other sources of trouble. They are men, materials, machines, methods, and management. The men at fault range all the way from engineers who create needlessly tight tolerances to the operator or inspector who lacks skill, tools, or qualifications. Materials cause trouble when they are not inspected and arrive at assembly points unfit for use, or are not to specifications, but must be accepted to avoid costly delay. Also at fault are poor design methods and manufacturing and inspection tied to antiquated procedures. Machines contribute to losses when design, wear, or age makes the meeting of tolerances impossible, or when designed for another use, or built as an expedient long ago. And finally, management shares in the blame when the policy requires constant deviation by inspection to accept bad pieces instead of making basic corrections.

Good plant design begins with an evaluation of the site. Then comes preparation of the ideal layout without regard to details. This should achieve the most efficient operation of each machine and department, reduce materials handling to a minimum, and be flexible enough to permit changes in production methods. Sometimes substantial savings can be made by abandoning a plant and starting fresh, so that competition can be met.

More capable and effective supervision of nonproductive departments, aided by staff service departments, will help to cut indirect costs. It pays to select men of higher caliber for training as supervisors and then give them the training and the data required for applying good supervisory techniques.

(This article is based on the secretary's report of panel on "Methods of Controlling Indirect Manufacturing Costs" held at SAE Tractor Meeting and Production Forum, Milwaukee, Sept. 12, 1955. Panel leader was C. E. Pflug, American Motors Corp.; secretary was R. C. Mortensen, American Motors Corp. Panel members were: E. L. Breese, Caterpillar Tractor Co.; A. D. Engle, The Austin Co.; E. J. Ferch, American Motors Corp.; A. J. Spelich, Waukesha Motors; H. Stoudt, Louis Allis Co. This report together with 6 other panel reports are available as SP-312 from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

New Guideposts To the Design of

High-Speed,

PROBLEMS in design of aircraft for high-speed, high-altitude flight upon which light is cast by recent researches with rocket-propelled airplanes include:

- Deterioration of directional stability with Mach numbers;
- Loss of damping and increase in the airplane's natural period as altitude is increased;
- Coupling effects of the airplane's inertia and aerodynamic characteristics; and
- Aerodynamic heating.

These are outstanding problems which face, not only the research airplane program, but the designer of any high-speed high-altitude machine.

Loss in Directional Stability

Deterioration of directional stability with Mach number is one of the most serious problems that has arisen. Fig. 1 shows the variation of directional stability parameter, with the Mach number.

As can be seen, subsonically and transonically, there is little change . . . in fact, somewhat of an increase in directional stability. Then, as the Mach number increases above 1, the directional stability begins to decrease at a rather alarming rate. And, as the Mach number approaches 2, it is quite a bit lower than at Mach number 1.

The main reason for this decrease is the decrease in lifting effectiveness of the vertical tail. The tail is balancing the unstable yawing moments of the fuselage, which are essentially unchanged with speed. So, since the tail effectiveness decreases,

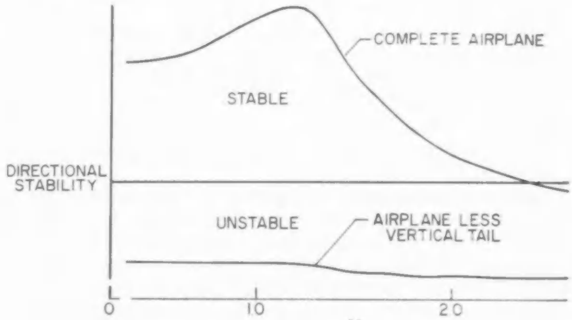


Fig. 1—Variation of directional stability parameter with Mach number. As the Mach number increases above 1, the directional stability begins to decrease at a rather alarming rate.

Walter C. Williams, NACA High-Speed Flight Station

Excerpts from paper "Flight Research at High Altitudes and High Speeds with Rocket-Propelled Research Airplanes" presented at the SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

High-Altitude Airplanes

. . . revealed by research results from rocket-propelled planes.

there is an overall decrease in the directional stability of the airplane.

Actually, it is not necessary for the directional stability to go completely to zero in order to have difficulties with these machines. In the dynamic case, depending on the relationships of directional stability to lateral stability, as well as inertia effects, violent oscillations in roll and yaw can occur as well as possible divergent motions. Some of the loss in directional stability can of course be handled by mechanical or electronic devices and the stability can be augmented artificially. (Studies are under way to find means of accomplishing increases in directional stability by aerodynamic means.)

Stability and Control

Loss of damping and increase in airplane natural period as altitude is increased also leads to unsatisfactory stability and control characteristics . . . when coupled with the loss of directional stability.

A typical case is shown in Fig. 2 where the variation of period and damping with altitude is shown for a constant Mach number normalized to that existing at 20,000 ft.

It can be seen in this figure the damping decreases seriously as the altitude increases and the period becomes quite long. This does mean, as far as the long period is concerned, it could be easier for the

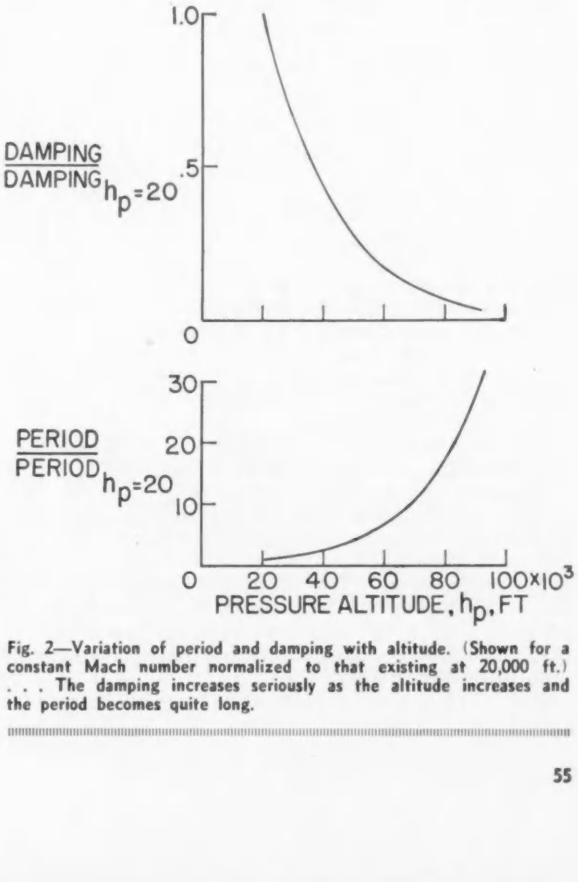
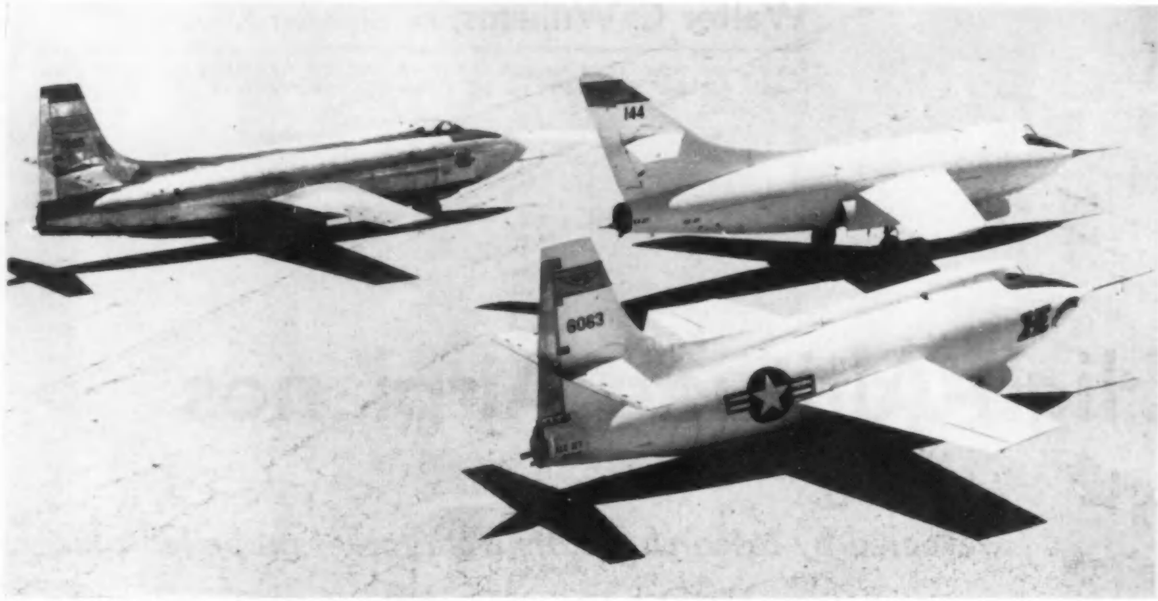


Fig. 2—Variation of period and damping with altitude. (Shown for a constant Mach number normalized to that existing at 20,000 ft.) . . . The damping increases seriously as the altitude increases and the period becomes quite long.



THESE ROCKET-PROPELLED RESEARCH AIRPLANES have made large advances in Mach number and altitude. Along with one other rocket-propelled plane, these are being used in the research program of the NACA's High-Speed Flight Station. (Left to right: X-1B, X-1E, and D-558-II. The X-2 is not shown.)

All these machines are launched from the B-29 or B-50 type mother ships, conserving all the rocket fuel for test work at altitude . . . and not consuming it in climbing from the ground to 35,000 ft.

pilot to control with the longer time involved. However, for such a long period the pilot has difficulty in determining whether he is encountering a diverging motion or an oscillatory motion of his aircraft.

In addition, the long period of the airplane, coupled with low damping, results in a response characteristic that gives the pilot an impression of little control although the effectiveness might be quite high. The damping is so very light at the higher altitudes that there is little doubt it will be necessary for the airplane to have automatic or artificial damping.

In our work with these rocket-propelled research planes, we have studied the loss of control effectiveness in the transonic and supersonic region, which coupled with the increase in static longitudinal stability, has made control over the complete angle-of-attack range difficult.

Blunting the trailing edge of a control surface by decreasing the angle between the two sides is a means of avoiding some of the large reduction in control effectiveness that occurs in the transonic regime. It does, however, bring about some increase in drag.

The problem of pitch-up and its alleviation was one of the problems forced on us by the swept-back planforms used on research airplanes (particularly the D-558-II) to alleviate the high drag associated with transonic flight.

The straight-wing airplanes, with moderate aspect ratio as used during World War II, had linear variations of pitching moment with lift coefficient or angle of attack as measured in the wind tunnel which gave straight lines and it was only necessary for the slope of these lines to be negative for satisfactorily stable airplanes. With the swept-wing configurations, however, variation of pitching moment with angle of attack is not necessarily linear and has abrupt changes in slope. Obviously, if the slope became positive, indicating static instability, it was apparent that stability difficulties would be encountered and the airplane would not fly satisfactorily.

In addition to the clear-cut case of very large changes in stability, some configurations gave wind-tunnel pitching-moment curves with varying degrees of non-linearity and varying degrees of abruptness to these non-linearities. Which of these pitching-moment variations would be satisfactory or tolerable was a moot question, and could only be answered by tests of various devices in flight, each of which successively appeared to give better wind-tunnel pitching-moment variations.

It should be noted that we have tried in flight only wing devices because it has not been possible economically to try different tail locations which are known to have an appreciable effect on the pitch-up tendency of airplanes.

Incidentally, it would be just as difficult to change tail location appreciably on an operational airplane.

The effect of principal inertia axis on lateral stability has been rather serious in that rather drastic reductions in dynamic lateral stability occur

as a result of inclination of the principal axis in a nose-down direction and has caused rather serious lateral oscillations at low angles of attack.

Combined Effects = Trouble

Coupling the effects of inertia and aerodynamic characteristics of the airplane is also causing increasing difficulties. Fig. 3, for instance, shows a time history of an oscillation experienced at high Mach numbers with one of the research airplanes. It shows the change in angle of attack, angle of sideslip, and rolling velocity with time.

As can be seen from the time history the airplane is undergoing a typical Dutch roll oscillation; that is, rolling and yawing is coupled. However, as can be seen, there is also an oscillation in pitch as shown by the angle of attack trace. This pitch oscillation is of an appreciable magnitude that occurred at twice the frequency of the rolling oscillation, and the phasing is such that as the airplane changes direction of bank angle, it begins a pitch cycle.

Studying inertia effects, we attacked the problems involved in dynamic conditions where the airplane mass is distributed primarily along the fuselage axis with light loading along the wings. In these cases, the aerodynamic effects are offset somewhat by the mass effects. The result is that, although a specific motion may be primarily about one axis, a resultant motion occurs about the other axes.

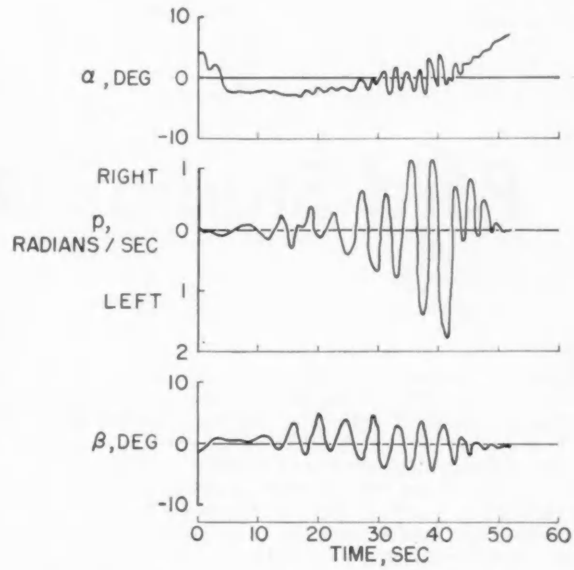


Fig. 3—Time history of an oscillation experienced at high Mach numbers with one research airplane.

Aerodynamic Heating

Aerodynamic heating is another problem we face as we increase speed. It is, of course, one of the newer problems. Since the adiabatic temperature rises as the square of the velocity, it is easy to see that the problem is much more serious for the X-1A at a speed of M = 2.5, than for the original X-1 at M = 1.5.

Actually we are just getting in to the aerodynamic heat problem. We've had some experience with the D-558-II which is reflected in the time history of the Mach number, the stagnation temperature, and the nose and wing-skin temperatures shown in Fig. 4. The maximum stagnation temperature was 200 F; and as expected, the nose and skin temperatures did not reach this value because of the heat transfer time and recovery factor.

The highest temperature reached on the nose and wing skin occurred after the maximum Mach number was reached and the speed was decreasing.

Actually, the temperature as shown is of no great concern, but it does show that we are getting the speeds of appreciable temperature rise, in this case 170 F above free-air temperature.

We are now engaged in a program using the X-1B airplane to study the effects of aerodynamic heating on the aircraft structure and the distribution of the heat through the structure.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members; 60¢ to nonmembers.

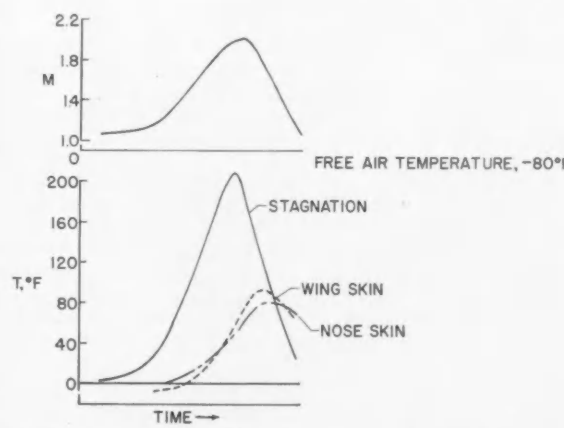


Fig. 4—Time history of the Mach number, stagnation temperature, and nose and wing skin temperatures from D-558-II experience. The highest temperature reached on the nose and wing skin occurred after the maximum Mach number was reached and the speed was decreasing.

Paul Klotsch and Gordon H. Millar,

Mechanical Department, Scientific Laboratory, Ford Motor Co.

Based on discussion of paper "The GMR 4-4 'Hyprex' Engine—A Concept of the Free Piston Engine for Automotive Use" by A. F. Underwood, General Motors Research Staff, presented at SAE Summer Meeting, Atlantic City, June 4, 1956.

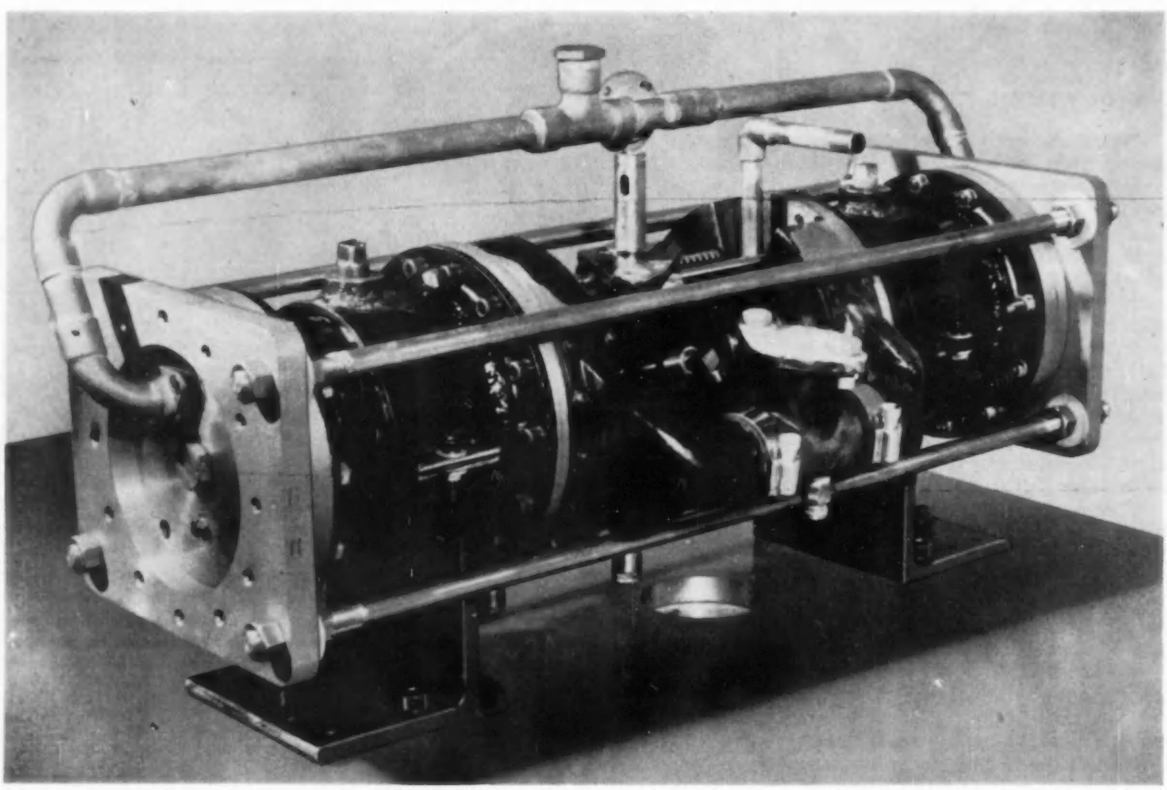
Ford Studies Dynamics of Free

FOR some time a free piston turbo-compound engine development program has been in existence in the Scientific Laboratory of the Ford Motor Co. The objective of this program has been to take a good look at the possible advantages offered by the free piston turbo-compound engine.

To implement this process several experimental free piston gasifiers have been designed and built. These machines are relatively small in size and operate at frequencies up to 3600 cpm.

Laboratory work with these machines has been directed towards obtaining a better understanding of the operation of free piston machinery above the usual 1000 cpm range. It is further desired to evaluate on a laboratory basis the piston motion-combustion process relationship under as many and as varied conditions of operation as can be achieved.

With regard to mechanical design it has been apparent from the results of engine tests that one pair of synchronizing rods is entirely adequate to keep the pistons in phase. The second set of rods is excess baggage, and the attendant difficulties with



ONE OF SEVERAL FREE PISTON GASIFIERS built by Ford's Scientific Laboratory to study possible advantages of gasifier-plus-turbine powerplant for ground vehicles. This particular experimental gasifier delivers under 50 gas hp.

Piston Gasifier

alignment and fastening do not justify their existence.

Motion studies by means of high speed photography have revealed piston motion characteristics unlike any known engines. Top graph at the right is a displacement-time curve obtained from an engine running at 1900 cpm. On the same graph is plotted a sine curve for comparison. The displacement curve is not appreciably different from a sine curve. But the center graph shows what happens when this is converted to a velocity-time curve and, further, the bottom graph shows the marked difference in accelerations. Acceleration is the important factor in keeping free piston machines in one piece.

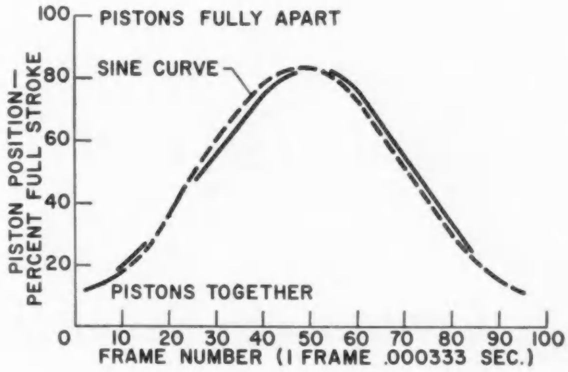
During the course of operation the effect of the combustion process on the piston motion, and the converse, has been studied. There is no question but what the variable stroke and lack of a fixed volume-time path are important influences on combustion in free piston machinery.

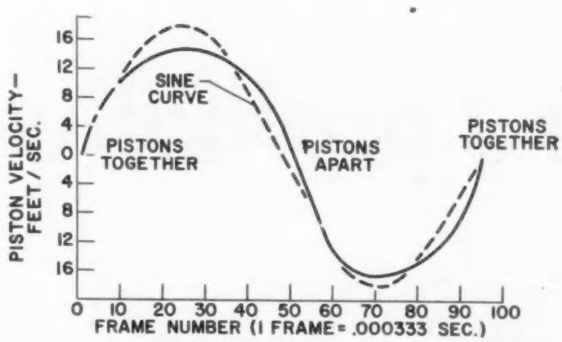
Gasifiers have been operated in the Scientific Laboratory on both gaseous and liquid fuel on both spark ignition and compression ignition at practically all conceivable air/fuel ratios. Carbureted and injection type fuel systems have been used interchangeably. It has been found possible to run at low power levels on spark ignition and as the pressure ratio is increased to change automatically to compression ignition. This change in operation on gasoline type fuels is practically undetectable except on a pressure-time card.

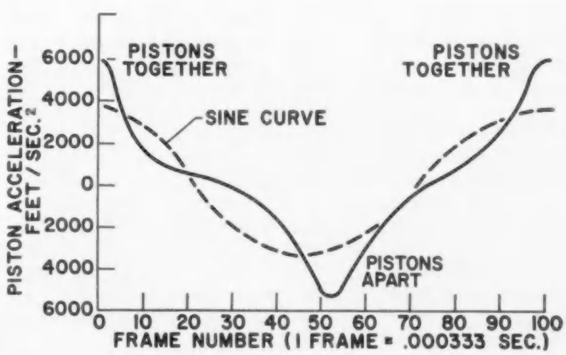
Propane also has been used as a fuel with spark ignition, and direct solid fuel injection was operated both with and without spark ignition. The completely different response of these experimental gasifiers to the normal parameters of fuel quality invites a major research effort.

Control of the free piston gasifier requires a basic knowledge of many parameters. Under some conditions of operation instantaneous starting and stopping at will has been achieved. Under some circumstances starting and stopping has not been so successful.

Complete control of the gasifier cannot be achieved by manipulation of the fuel alone. The fuel must be regulated along with other parameters to achieve stable and smooth control.







PISTON MOTION CHARACTERISTICS reveal themselves in high speed photographs to differ from those of crankshaft engines. Top graph shows that displacement-time curve obtained from free piston gasifier running at 1900 cpm differs only slightly from sine curve. But difference increases when first and second differentials are plotted. Free piston accelerations are about half again as great as those with sine motion. Forces, of course, are proportional to accelerations.

Cooperative Tests

Confirm the Belief that

Locomotives Can Use

EIGHT full-scale field service tests in railroad diesel locomotives of fuels selected to investigate the effect of variations in sulfur content, ignition quality, and end point have been completed. These tests were conducted under the sponsorship of the Coordinating Research Council during the period May, 1949 to June, 1955.

Comparisons were made with the narrow range of 2-D railroad fuels which the railroads had been accustomed to burn and which averaged 0.34% sulfur, 50 cetane number, and 631 F end point. Results indicate the 2-D fuels having 1% sulfur, approximately 40 cetane number, and 700 F end point can be used without interfering with operations, but that the engine conditions were not as good in respect to deposits, wear, and effect on lubricating oil and filters.

The following conclusions can be drawn on the basis of the tests:

1. The over-all approach to full-scale testing employed in this project appears to be a valid means of determining the effect of variation in fuel properties on railroad diesel engines.
2. Considering only the sulfur content, cetane number, and end point as physical properties of the test fuels, it was possible to operate the locomotive diesel engines under study without sacrificing locomotive availability.
3. In considering application of fuels of the type under test in this program, it should be noted that fuel properties other than sulfur content, cetane number, and end point may adversely affect locomotive operation or maintenance. Instability and high cloud and pour points are examples of such properties which were encountered in these tests.
4. Due to wear or deposits, increased engine maintenance such as more frequent change-out of power assemblies may result when using fuels of the type under test. This trend depends on the nature of the test fuel used, the nature of the locomotive operation, and maintenance practices, and was observed in 16 out of the 17 test fuel engines.

The project was undertaken as a result of recommendation of the American Petroleum Institute and the Western Petroleum Refiners Association based on general concern for the future availability of straight run fuels of 50-plus cetane number specified by most railroads. In 1946, the Coordinating Research Council established a group to survey current and future diesel fuel characteristics and to determine the possible future trends in diesel fuels likely to develop.

A survey was likewise made covering the locomo-

R. W. Seniff, Baltimore & Ohio Railroad Co.
Leader of the Group
and
F. A. Robbins, Koppers Co., Inc., Metal Products Division
Leader of the Analysis Panel
CFR-DFD Group on Full-Scale Field Service Tests of Railroad Diesel Fuels of the Coordinating Research Council, Inc.

Based on paper "Full-Scale Field Service Tests of Railroad Diesel Fuels" presented at SAE Annual Meeting, Detroit, Jan. 11, 1956.

Lower-Cetane Fuels

tive manufacturers' and railroad specification requirements for diesel fuels. The survey covering diesel fuel characteristics indicated that future diesel fuels in greatest supply would tend to be of higher sulfur content, lower cetane number, and higher final boiling point. Specifically, the predicted levels of these properties were 1.0 ± 0.2% sulfur content, 40 ± 2 cetane number, and about 700 F end point.

In each test two or more similar locomotive units were used for approximately one year. The units were equally divided between test fuel, prepared as close as practical to the levels predicted in the fuel survey, and control fuel, which was the fuel normally used by the railroad. In each test, the test and control fuel units were assigned to similar service. Special precautions were taken to prevent mixing of test and control fuels. Since the locomotives were not new at the beginning of the tests, at least two precisely measured power assemblies—which consisted of pistons, rings, cylinders, cylinder heads, connecting rods, and related bearings—were installed in each engine. These measured assemblies were removed at the conclusion of the test and were measured and inspected to determine significant differences in deposits and wear.

The eight tests covered by the Program involved a total of 34 diesel engines of three makes and were equivalent to approximately 38 engine test years. Of these engines 17 were operated on test fuels and

Table 1—Test Locomotives and Operating Data.

RAILROAD	1	2	3	4	5	6	7	8
LOCOMOTIVE BUILDERS CODE	JA	KA	LA	LB	KB	JB	LC	LD
NO. OF LOCOS. INVOLVED	2	2	1	2	2	2	2	2
NO. OF UNITS INVOLVED	2	4	2	4	2	4	4	6
TYPE OF SERVICE	AVE. SWITCHING	MOD. FRT.	MOD. HIGH SPEED PASS.	HVY. FRT. SANDING UNDER POWER	AVE. DUTY FRT. SAND. UNDER POWER	RD. FRT. PUSHER	MED. DUTY FRT.	HVY. FRT. SANDING UNDER POWER
TERRAIN	FLAT	GENTLY ROLLING	FLAT	MOUNTAINOUS	GENTLY ROLLING	MOUNTAINOUS	HILLY	MOUNTAINOUS
LOCOMOTIVE HORSEPOWER PER UNIT	1000	1800	2000*	1500	1800	1250	1350	1800
NO. OF ENGINES, TEST	1	2	2	2	1	4	2	3
CONTROL	1	2	2	2	1	4	2	3
TOTAL	2	4	4	4	2	8	4	6
NO. OF MEASURED POWER ASSEMBLIES ON TEST, TEST	3	4	4	4	2	8	4	4
CONTROL	3	4	4	4	2	8	4	4
TOTAL	6	8	8	8	4	16	8	8
DURATION OF TEST (MONTHS)	12	11	12.1	6.3	17.0	11.8	12.8	13.5
AVG. TOTAL TEST MILES/UNIT	—	64,000	204,000	45,000	71,500	43,000	149,000	104,000
TOTAL GAL. TEST FUEL USED	58,000	294,000	381,800	216,000	126,500	310,000	598,000	601,000
AVG. MILES PER UNIT MONTH	—	5,450	17,000	7,100	4,200	3,700	11,700	7,700
AVG. GAL. PER UNIT MONTH	4,800	10,900	24,800	17,100	8,150	12,400	23,400	14,800
HOURS OF IDLE PER DAY	9.5	9.0	11	16	2**	12	9	17.5
HOURS OF LOAD PER DAY	14.5	15.0	13	8	7**	12	15	6.5
AMBIENT TEMP., MAXIMUM, °F.	100	98	100	90	100	99	100	100
MINIMUM, °F.	10	−20	−10	−5	20	10	−38	−5

* TWO ENGINES PER UNIT. ** LOCOMOTIVE SHUT DOWN 15 HOURS PER DAY.

17 on control fuels. The test program covered approximately 2,500,000 unit miles of combined high-speed passenger and average-duty to heavy-duty freight operation and 8000 hours of switching service. Approximately 2,500,000 gal of test fuel and an equivalent amount of control fuel were consumed during the tests. Table 1 gives a description of the diesel locomotive units employed in the study, the type of field service covered, and the conditions under which the equivalent was operated.

In addition to control analysis of fuel and lubricating oils during the tests, the U. S. Bureau of Mines, Petroleum Experimental Station at Bartlesville, Okla. obtained analytical data on the distribution of sulfur and type of hydrocarbons throughout the boiling range of each fuel. The behavior of the fuels was also studied by them in the constant volume bomb and the Bureau has offered that data as additional information.

Two independent laboratories volunteered test data on certain of the fuels in two- and four-stroke-cycle small-scale engines. One laboratory used the same lubricating oils that were used in the railroad engines. The other used their standard straight mineral test oil.

Test Fuels Show Drawbacks

The following general results were established:

1. All eight full-scale railroad field tests produced data which could be interpreted with respect to the purpose of this project.

2. The use of test fuels did not affect locomotive performance or suitability for its assigned purpose. However, in order to keep test locomotives operating, in certain cases corrective measures had to be taken to overcome filter clogging caused by the high cloud and pour points of the fuel or injectors sticking caused by products of fuel instability which were deposited on injector plungers and barrels.

3. The test fuel caused greater wear or deposits in seven out of the eight tests. The following tabulation indicates the number of locomotive units out of the 17 units on test fuel which had greater deposits or wear than the companion control fuel units.

Piston skirt lacquering	16
Cylinder liner bore wear (See Fig. 1)	12
Piston ring wear (See Fig. 2)	11
Cylinder liner bore deposits	9
Cylinder liner port deposits	9
Wrist pin bushing deposits	9
Rod eye wear	9
Valve deposits	9
Injector deposits	8
Ring groove wear	8
Ring groove deposits	5
Crankcase deposits	5

It appears significant that no clear-cut beneficial effect of test fuel was noted in any case except a minor instance in one test where the fuel strainers and filters were cleaner with the test fuel than the control fuel. Examination of the fuel oil analysis disclosed that this test fuel had a lower gum content than the control fuel used in this test.

4. The small engine investigations conducted on several of the test fuels and control type fuels exhibited trends similar to those observed in the full-scale service tests with respect to deposits and wear.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

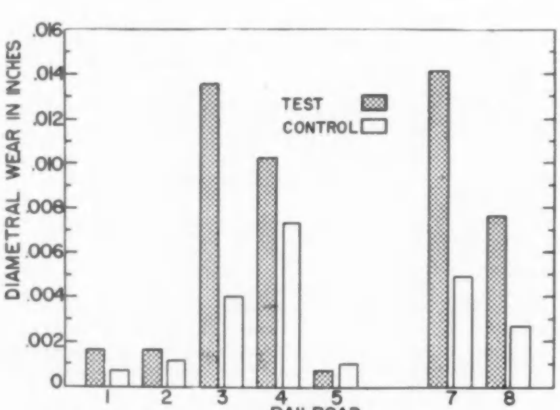


FIG. 1 AVERAGE ANNUAL TOP CYLINDER WEAR

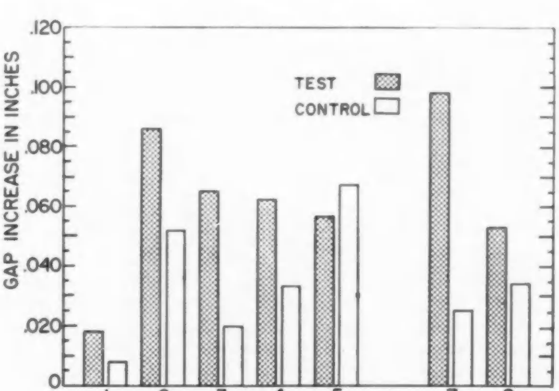


FIG. 2 AVERAGE ANNUAL TOP RING GAP INCREASE

Advice to young engineers from an engineering executive

Get "Educated" Before You Specialize Too Much

J. T. Dyment

Director, Engineering, Trans-Canada Air Lines

Excerpts from paper "Engineering Education" presented at SAE Montreal Section, Jan. 16, 1956.

THERE were 180 specialized engineering degree courses within the broad scope of mechanical engineering alone in the United States just a few years ago. The majority of these still exist. Three examples are automotive, aeronautical, and marine engineering. Parents are continually asking where their sons should go to take aeronautical engineering. They do not know that it would be far better for their sons to stay near home and take a basic engineering course and then go and take aeronautical engineering as post graduate work. Similar situations exist in the other four basic fields of engineering—electrical, civil, mechanical, and mining and metallurgical.

The desire for specialization in undergraduate years by students, parents, and many educators is an appalling situation in view of the fact that the leading engineers, industrialists, and educators are unanimous in their agreement that the four years of undergraduate college education should be devoted exclusively to obtaining a basic education.

The existing specialization in many colleges in Canada and the United States is actually handicapping the student and costing employers money.

Much as we would like to have your engineers trained for our particular requirements, a moment's reflection of the infinite number of specialized requirements in industry, and of the terrific developments taking place in almost every field of engineering, tells us it would be impossible for any number of years of college training to equip a student to drop into any business with more than a few of the answers.

Aside from the futility of trying to meet specialized requirements through college courses, such specialization is unfair, and a handicap, to the student for another reason. Statistics show that less than 20% of engineers are practicing in the field of engineering for which they prepared themselves in college. Most engineers today wish they had taken broader and more fundamental courses during their undergraduate days.

We in industry would willingly train a new graduate for our own field of engineering if assured that, when hired, he could properly express his thoughts both orally and in writing; if he knew how to attack a new problem or analyze a situation; if he knew where to go for information and how to use it when he found it.

We older engineers are inclined to be inarticulate and prefer to leave the expressing of our own coordinated opinions to some other fellow.

So, no one takes on the job of bringing high school and college educators and parents up-to-date with the current thinking of the engineering profession. I say "of the engineering profession" because surely the recommendations of such an organization as the American Society for Engineering Education should better represent the opinions of the profession than our own. We as individuals frequently don't help the situation by griping about the difficulties of obtaining engineers for our own particular type of work. We give the impression to parents and educators that there would be a big demand for students trained in a particular field.

What do we in industry want to find in a newly graduated engineer?

What should we do, and what should he do to

further his training as an engineer after he graduates?

An "educated man" regardless of his profession or business, should have some knowledge and understanding of history and human development. He should have a capacity to understand and enjoy our cultural heritage in arts, letters, music, painting, literature, and so on. He should have some understanding of our contemporary society and of himself as a human being in the physical, physiological, and psychological senses. This should include an understanding of one's emotional nature and the capacity to subject one's self to self-discipline. He should also know something of the physical world around him and about the importance of science in respect to that physical world and of his own life and society.

He should have acquired certain skills and information which he can turn to practical use to make a living. Most important of all is his acquisition of wisdom and of judgment and a balance of standards of value, and of a capacity or ability to discriminate and to make right and wise choices. Men are men before they are engineers, doctors, or lawyers. If they are made capable men they will be capable engineers, doctors, and lawyers.

Engineers must know people and how to work with them, as well as knowing materials and processes, in order to achieve administrative competence and cultural breadth.

When a manufacturer recruits young engineers today he is generally looking for potential managers. He wants men with a sense of order, a quality of accuracy, skill in problem solving, ability to visualize clearly, logical thinking, ability to express himself adequately, the enterprise for getting things done.

Industry as a whole requires young engineers:

(a) capable of applying basic principles to the creative solution of new problems which will constantly arise in a dynamic technology.
(b) capable of contributing to the solution of man's social problems.
(c) with an educational program sufficiently flexible to meet the changing desires which come with maturity.

Industry in its turn must provide the training in specific applications which cannot be effectively given in college.

Today it is generally realized that there is no substitute for industrial experience, no way to develop mature judgment or an up-to-date knowledge of current practice other than by growing up in the proper industrial atmosphere.

For complete paper (in multilith form) on which this abridgment is based write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

Expense Controls . . .

. . . are due for big change. Direct labor is becoming a less reliable base as mechanized processing pushes overhead out in front as cost factor.

Based on report by **A. E. Stukey**, Thompson Products, Inc.

STAFF groups may design the techniques and develop the standards for an expense control program, but it must fit the employees, their aptitudes, training, and interest, and it must be supported and used by all levels of line management. Here are eight pointers to help in organizing such a program:

1. Tie the program to the company's operating plans and objectives. As a starter, compute standards by forecasting sales revenue, deducting desired profit and direct cost of labor and material, then apportioning remainder to various cost centers and expense accounts. Refine this by establishing predetermined standards of expense to accomplish units of work.

2. Develop expense standards by analysis of past expense or by engineering studies. Use history when the pay-off is small, but exclude unusual and non-recurring expenses before computing standards. Use engineering studies when the pay-off is greater.

3. Don't be restricted by traditional relations of expenses to direct labor hours in expressing standards. If certain expenses vary with the number of set-up occurrences or machine-hours, use them as a base for measuring performance for those expense accounts on the floor.

4. Report expenses and activity accounts properly and accurately lest performance variances be obscured by reporting errors.

5. Hold supervisors responsible only for those expenses which they control, and make clear in job descriptions what their responsibilities are.

6. Prepare expense performance reports with frequency and speed. Ease the accounting department's load by segregating expenses as to frequency of reports required.

7. Decide whether to set expense standards at average or high-task levels. You get more for your money when your sights are set higher.

8. To help reduce and standardize the salary expense of the general office departments, throw historical ratios of expense to sales or labor dollars out the window. Develop a work program for each department, listing projects they must or would like to undertake. Specify type of labor required for each project, then estimate labor required to complete each project and any tangible results anticipated. Get top management's approval as to which projects should be tackled and the desired completion date. Make allowance for normal delays, and you have a standard of the amount and type of labor required for each department for the period encompassing the project completion dates.

The development of highly complex mechanical and electronic manufacturing processes raises seri-

ous problems for the expense control team to meet. The big expense money is shifting from labor to overhead. Expenses of secondary interest in the past will be the prime problems of tomorrow, and refined methods for standardizing expenses will become more important. New bases will be required as direct labor becomes less reliable as a base to which to relate expenses.

(This article is based on the secretary's report of panel on manufacturing expense control held at SAE National Production Meeting and Forum, Cleveland, March 19, 1956. Leader of the Panel was E. F. Gibian, Thompson Products, Inc.; secretary, A. E. Stukey, Thompson Products, Inc.: Panel members were: H. C. Boyer, Chevrolet Div., General Motors Corp.; P. Donis, Caterpillar Tractor Co.; J. D. Lightbody, Clevite Aero Products, Clevite Corp.; N. Olijnek, Minneapolis-Honeywell Regulator Co.; H. J. Schmidt, Robert Heller & Associates, Inc. This report together with 6 other panel reports are available as SP-314 from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Cooling Problems . . .

. . . do arise with earthmoving machinery when mounted equipment obstructs the air stream or fluid flow. If radiators fail to function as expected, this may be the reason.

Based on paper by **E. H. Panthofer,** Perfex Corp.

THERE are seven things we expect of a radiator and if they all happen as anticipated, then we can expect to be free of trouble. If equipment mounted outside the vehicle or squeezed under the hood prevents proper functioning of the radiator, then we are in for trouble. We can illustrate this by examining the seven expectations, item by item.

We assume the coolant to be free of vapor such as air, steam, or combustion products. Entrainment of air usually comes from loose fittings, leakage past the pump bearing, or leakage of exhaust gas through the head gasket. Steam may come from localized hot spots in the engine, or from flashing at the pump inlet because of high vacuum at that point.

We expect a uniform flow of coolant through the radiator. But sometimes heat exchangers, used with torque converters, are placed on the suction side of the pump to take advantge of the coldest water. This restricts the suction side and increases the chances of pump cavitation. Frequently, mounted equipment is so placed as to require the radiator outlet to look like a corkscrew, which adds resistance to flow and interferes with pump action.

To expect that the full area of the radiator is usable is certainly warranted. But often we find such items as dozer blades, hydraulic units, and even lamp brackets obstructing all but a portion of the radiator, which results in a direct reduction of usable area. Hydraulic units occasionally leak oil and if the units are mounted in front of the radiator in the airstream, there may be trouble. With a suction fan, the oil is picked up and the radiator acts as an oil filter. The radiator then picks up dirt and can become completely clogged, to lose as much as 30% of its efficiency.

We expect a uniform air velocity through the radiator. Actually, we rarely get it in practice. One reason lies in the disproportionate amount of air delivered by the outer third of the fan. With conventional spacing of fan and core, there is rarely room for the airstream to average out; hence a high velocity stream of doughnut shape will exist. Lower velocities will be present at the center and corners of the radiator. Other items affecting airflow uniformity are: engine configuration, accessory and mounted equipment and their location, type of fan.

We should be able to rely on a certain calculated quantity of airflow. With approximately 45 cu ft of equipment and engine in 44 cu ft of under-the-hood space, confined and screened hood sides, airflow sometimes becomes infinitesimal. Add to this front end shovels, protective screens, and grilles—and airflow is something you don't get. On equipment where closed hoods are used, it is usually imperative to use louvers. The most desirable location can be determined by operating the equipment without hood sides to reveal the natural airflow pattern. The problem then is to convince the stylists that this location will not impair appearance and that thought must be given to keeping the equipment operator from overheating.

We expect entering air temperature to be uniform and at a specified number of degrees, but the recirculation of hot discharged air back to the entering airstream may upset calculations. This air will pass through the core several times and its temperature will tend to approach that of the coolant. Mounted equipment can cause recirculation or prevent it, depending on whether it disperses or deflects the air back to the fan. If it returns the air, the effect will be proportional to the volume returned. Thus, an item in the high velocity area can cause recirculation of the major portion of the airflow.

A radiator clean inside and outside can be expected, but much earthmoving equipment is subject to clogging from leaves, Spanish moss, dirt, and dust. The little pockets of a radiator tend to become clogged and act as filters for the picking up of more particles. Front end mounted shovels can drop particles of dirt into the fan blade which hurls them into the radiator with sand-blasting effect. Cores have been found with as much as 30% of the fin surface blasted away, yet the effectiveness of a radiator is calculated on a full complement of fins. (Paper "Cooling Problems Due to Mounted Equipment" was presented at SAE Central Illinois Earthmoving Industry Conference, Peoria, April 4, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Tubeless Tires

please

SELDOM have fleet men been so enthusiastic with such meager experience as they are over tubeless tires. Usually the preponderance adopt a "wait and see" attitude towards any innovation, but the bulk seem to be willing to go on record as saying that tubeless tires are here to stay, and they are good.

Too often the problems connected with growing pains come before the demonstrated benefits and this dictates a cautious stance. With tubeless tires the early problems have been encountered and they are not serious. Experience so far indicates a number of benefits; chief among these is a reduction in the number of flats.

Most serious problem facing the fleet operator is the result of a disagreement among the tire manufacturers. Some of them say that the insertion of a plug from the outside will repair a puncture satisfactorily. Others insist upon the inside air-curing patch as well as the plug. This puts the operator in a quandary. Just what kind of service bulletin is he to issue to his field force? The more the fleet is scattered, the more acute the problem becomes.

The tires themselves show performance equal to or better than their tube type predecessors. Here are some of the factors:

Number of Changes—With 1522 tube type tires rolling in a heavy steel hauling operation, 683 tires had to be changed in a three and one half months period because of flats. Working alongside were 300 tubeless tires which required only 60 changes during the same period. The change ratio dropped from 45% on conventional tires to 20% for the tubeless.

An over-the-road operator with 4040 tires rolling has had 161 shop flats and 41 road flats during a nine month period. One hundred and fifty air curing patches have been applied and three came loose. Thirty-one plugs installed are still in place with no sign of failure. Other operators indicate experience of about the same order.

Methods of Repair—Experience with the outside plug repair is reported as extremely good by a number of operators. If the inside patch and the outside plug are used, some 10 minutes can be saved by patching the tire instead of the tube—plus the time consumed in getting the tube and flap back into the tire. That's very definitely on the plus side for tubeless tires in the opinion of most operators.

One operator reports using a resealer instead of a plug. Except that some few plugs have hardened, failure of repair methods is virtually unknown.

Ease of Changing—The vote goes solidly for the tubeless tire, with the caution that a green hand can ruin the seal on a tubeless tire by indiscriminate use of hand tools. Power tools seem to be the answer wherever they can be justified—but this goes for both types of tires.

Tubeless tires must be lubricated at installation for two reasons. First to eliminate that awful wrestling match in getting the tire on and second to assure a proper seal. There is still some doubt as to what the lubricant should be. One thing is sure. It cannot be mineral oil. Some fleets are using a vegetable oil and some are using soap of one kind or another. It has been suggested that liquid hand soap is satisfactory.

Rim Corrosion and Bending—A steel hauler reports rim bending about twice as often with the tubeless tires. Other operators find the incidence about the same with the two types. If rim cor-

Henry Jennings
Technical Editor, Fleet Owner magazine, McGraw-Hill Publishing Co., Inc.

Panel secretary's report on Round Table on Operators' Experience with Truck Tubeless Tires held at SAE Summer Meeting, Atlantic City, June 6, 1956.

truck operators

rosion is going to be a problem, no one knows it yet. One operator reports some instances of tires vulcanizing to the rim and even suggested buffing the rim at all changes.

Valves—Several fleets had some trouble with leaks around the valve at first, but this has been licked by using a neoprene sealing ring. This is common practice now. Some fleets like the two piece valve for ease in changing the stem, but in general they prefer the one piece valve because it is not subject to damage in nesting.

Recapping—It is too soon to know much about this. In one fleet having 361 recapped tubeless tires, six tires have been removed because of recapping difficulties. This would be par for the course with any type of tire. Some 40 tires had section repairs without any failures.

Tread Wear—This ranges all over as it always will because of the different types of service. Over-the-road tires are going 70,000 to 80,000 miles before recap. Comparisons in various operations lead fleet operators to believe that tread wear will be about the same—with some optimists favoring the tubeless tire on the basis of what they know now.

Experience with New Vehicles—Vehicle manufacturers definitely have not been on the ball. Bad mounting practices, many times without lubricant, have resulted in a faulty seal and underinflation. Thus tires are injured before they are put into service. One fleet inflates to 100 psi and then lets pressure down to proper level, to get good seal, and wants the vehicle manufacturer to do the same.

Tire manufacturers say that word has finally got around to vehicle manufacturers, and these conditions are rapidly being corrected. But fleet operators still feel that it is a good idea to make a careful inspection of tires upon vehicle delivery.

Weight Saving—It is definitely there. Savings of from 10 to 40 lb per wheel are quoted, depending upon the size.

Ride—Most operators cannot find any difference. There have been some scattered driver reports which favor the tubeless tire.

Serving on the panel which developed the information in this report were:

panel leader

Warren A. Taussig, Burlington Truck Lines, Inc.

panel secretary

Henry Jennings, Fleet Owner magazine

panel members

P. F. Schaffer, Norwalk Truck Line Co.

A. Walter Neumann, The Willett Co.

E. Bert Ogden, Consolidated Freightways, Inc.

C. W. Van Patter, Wilson Freight Forwarding Co.

TECHNICAL COMMITTEE *Progress*

Aero Instrument Panel Group Eyes Future Transport Needs

M. G. Beard, Chairman, SAE Committee S-7, Cockpit Standardization

NEW aircraft flight instrumentation developments are advancing rapidly to meet requirements of high-speed flight and modern navigation and traffic control systems. SAE Committee S-7, Cockpit Standardization is keeping alert to these changing needs and is carefully evaluating proposed improvements in instruments and arrangements so as to keep up to date its standards on instrument panel arrangements.

The advent of turbojet-powered commercial transport airplanes has intensified the interest in Committee S-7's work on cockpit standardization, particularly as regards its instrument panel standard, SAE Aeronautical Standard 278. For that reason, a review of the background of this work and the direction in which it is headed may be of interest.

During the Korean war when the airlines were requisitioned for transport airplanes and crews to implement the Korean airlift, it was discovered that no two airlines had the same instrument panel. In many cases, even the cockpit configurations were changed on otherwise identical models, so that it was necessary to bring the crews to the field an hour or more earlier to be briefed on the eccentricities of the particular cockpit they were to fly on the next leg.

Government authorities responsible for the national defense planning decided to correct this defect and in due process, the Civil Aeronautics Board was requested to obtain standardization—especially as to instrument panels and, wherever possible, throughout the cockpit. Since this is an area where industry can very well monitor its own problems, the matter was referred to the Air Transport Association which in turn requested the SAE to organize a committee for cockpit standardization. This was accomplished in 1950.

Since the purpose of this standardization was primarily for national defense, it is essential that good coordination be maintained between the industry and the military committees working on cockpit standardization. Although Committee S-7 was formed in 1950 and issued several SAE Aeronautical Recommended Practices on cockpit standardization, it was not possible to analyze all the factors and arrive at a suitable panel and attain agreement between industry and the military committee until 1953. As soon as agreement was obtained, the CAB placed the subject on the agenda for the Review of Regulations of that year. At that meeting, all parties having an interest in instrument panels agreed that it was a suitable standard.

The CAB incorporated it in the regulations as the national standard. Since that time, all new transport model airplanes—military and commercial—have had this panel installed, as have a large number of corporate airplanes. Some airlines have voluntarily installed the panel retroactively on their existing fleets.

The instrument panel as shown in AS-278 is really one single panel when considered for the functional assignment of each instrument location. The Committee realized, however, that there were at that time and always will be various degrees of standard and integrated instrumentation used on the different panels.

Therefore, AS-278 was issued to indicate how the various degrees of instrumentation would fit into the panel:

First, as a simple ILS (Instrument Landing System) system;

Second, the ILS combined with the RMI (Radio Magnetic Indicator);

Third, with the Collins type integrated flight instruments (which was the only integated system available at the time);

Fourth, with the Sperry zero reader.

Subsequent developments have brought out two additional integrated flight systems both of which were adapted functionally to the space assignments.

During the many months in which both the military and the industry committees were working on systems of panel arrangements, they reviewed all of the information available on eye motion studies from both the Air Force and the Navy. The Instrument Panel Subcommittee members discussed various principles and philosophies of instrument relationships and groupings with many professional pilots in their respective sections of the country. Eye motion studies stressed the frequency of sweep between the attitude and the heading instruments and also the greater efficiency with which the eye sweeps laterally than vertically.

It was because of this finding that the greater part of the preference was for a lateral relationship between the horizon and the directional gyro. Only the six basic instruments were fixed in the standard panel. The directional instruments are on the vertical centerline; the fundamental attitude instruments are on the right; and the air data instruments, airspeed indicator and altimeter on the left. Arrangment of accessory instrumentation was permitted around the basic six as would best fit into the size, shape, and location of the flight instrument panel.

Recently, in anticipation of turboprop and turbojet transports and in evaluating the various integrated flight instrument systems now available, a group of Air Line Pilots Association pilots have come out with a proposed arrangement of the Collins integrated flight system with a vertical relationship between the two instruments, the approach horizon being on the top row and the course indicator directly below it in the second row.

The instrument locations in this proposed panel are almost identical to a panel which was discussed with great favor among the Committee members

along with three or four other panels from which the present one was selected. The proposal is a good panel and has features which many consider as acceptable for a standard arrangement as the one which is now the national standard.

Committee S-7 invited the ALPA to present the panel at the Committee's March meeting in San Antonio. Committee S-7 endeavored to obtain all of the background and the basic principles behind this new proposal. So that the Committee members might have time to study and analyze the proposal, no action was taken at the March meeting. The Subcommittee on Instrument Panels scheduled a meeting on June 5 and 6 for the primary purpose of considering the new proposal in its relationship and timing to the new instrumentation under development by the Navy and the advent of turboprops and turbojets in airline operation.

In considering the ALPA proposal, Committee S-7 searched for any basic reasons which would warrant changing the standard and considered whether principles improving safety and greater efficiency are involved.

Greatly improved new instrumentation introduced since 1953 requiring change in functional space arrangement and adopted for use by the airlines would warrant a change in the standard. In this instance, no new instrumentation is involved since the integrated flight instrumentation on the proposed panel is identical to that shown on Plan 3 of AS-278. A fundamental change in principle and philosophy of arrangement would warrant a change. The proposed panel contains an arrangement of the basic instruments identical to that of a panel under consideration when the final space assignment of AS-278 was selected. Eye motion studies indicated greater efficiency of eye sweep horizontally than vertically, which determined the horizontal relationship between the horizon and heading instruments on the national standard panel.

There have been no eye studies made of integrated flight instrumentation. Committee S-7 is recommending that such studies be made to determine whether the basic principles of the horizontal relationships between the horizon and the directional gyro should be changed when these two functions are integrated into dials with the other functions of an integrated flight system.

To date, Committee S-7 has not yet found those factors which would warrant a change in its Standard.

Committee S-7 plans to continue to study and evaluate carefully developments in flight instrumentation systems as rapidly as they are introduced or proposed. It intends to keep reports and recommendations abreast of best collective technical thinking in the industry.

technishorts . . .

AUTOMOTIVE FLEET RADIO—Subgroups on Physical Dimensions, Power, and User Experience have been appointed by the Subcommittee on Radio Communications Suitable for Automotive Fleet Applications. The Subcommittee, under Chairman W. C. Baylis of Niagara Mohawk Power Corp., plans to consider (1) space and performance requirements for radio and allied equipment, (2) general recommendations for location of antenna and transmission lines, (3) power requirements, (4) radio operating requirements, (5) moutings, (6) maintenance and installation, (7) safety and noise suppression, (8) selective calling, and (9) future size and performance expectations.

The Subcommittee is part of the SAE Transportation and Maintenance Technical Committee.

FRICTION COEFFICIENTS OF MATERIALS—A test code on the evaluation of friction materials submerged in oil is to be developed by the Design Subcommittee of the SAE Transmission Committee. Loads, sliding speeds, and temperatures are to be variables. Also, the Subcommittee may work out a classification of fluids.

Among its other projects are a recommended form for reporting characteristics of transmission springs and a standard on mountings for temperature-measuring instruments.

AIR BRAKE TUBING—A performance standard on air brake tubing is under development. It is expected to cover internal and external corrosion of tubes, compatibility between various materials, and tubing life.

The work is being done by the Air Brake Tubing Subcommittee of the SAE Tube, Pipe, Hose, and Lubrication Fittings Committee. L. E. Manning of GMC Truck & Coach is chairman of the subcommittee. He will welcome reports on field experience with air brake tubing life from vehicle operators.

Technical Board Creates Two Policy Committees

THE SAE Technical Board has set up two new committees: one to develop guideposts for the operation of SAE technical committees and the other to establish policies on distribution of technical committee reports.

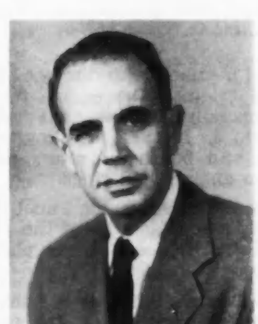
The proposed scope for the Guideposts Committee empowers it to:

"Develop for technical committees and their members a guide to sound operations, growing out of the Technical Board Rules and Regulations and currently successful committee practices and traditions, aimed at:

"1. Bringing about a uniformity of understanding of Technical Board principles and philosophies, yet permitting a maximum of operating autonomy in each committee.

"2. Preserving and extending satisfactions to engineers from their technical committee participation."

Membership of the Guideposts Committee includes Trevor Davidson of



Davidson

Arnold

Bucyrus-Erie who is chairman, Joseph Gurski of Ford, Arthur E. Smith of Pratt & Whitney Aircraft, Earl Pierce of General Motors, C. L. Sadler of Sundstrand Aviation, and W. S. James of W. S. James & Associates.

The proposed scope for the Publication Policy Committee calls for it to:

"Establish policies and guidance on the distribution of technical reports and information developed by committees under the Technical Board. Such guidance will consist of:

"1. Criteria to permit determination of the most feasible method of distribution in line with breadth of interest of each report and cost considerations.

"2. Definition of report classification so as to establish uniformity of classification by all committees.

"3. Suggestions aimed at achieving greater uniformity and consistency of format and organization of reports."

Membership of the Publication Policy Committee includes: C. F. Arnold of Cadillac as chairman, R. P. Trowbridge of General Motors, M. L. Frey of Allis-Chalmers, and Harold Nutt of Borg & Beck Division of Borg-Warner.

Tooling Panel Studies Engine Roller Stands

Photographed at a recent meeting of the Tooling Panel of Committee E-21 were (seated, from left) H. Wainwright, L. M. Shipley, Frank Gentry, David Kravitz, H. E. Spencer, August Brunell, and (standing) T. A. Lyle, R. M. Harding, Blair Ludemann, Harry Kirkwood, Harry Smith, and Ralph Ward. Not shown are Alden Beaton, L. B. Hansen, and G. P. Ludwig.

MAIN topic at the Tooling Panel meeting at which the above photograph was taken was the driving and locking of the rings of engine rollover stands. The Panel is carrying out tests to determine if the ring which suspends and "rolls" the engine should be driven by friction or by a positive-drive mechanism. The Panel's choice of method will depend on the coefficient of friction of ring and roller materials under field operating conditions and the possibility of locating the center of gravity of the engine at or near the geometric center of the rings.

Panel members also discussed a system of "riding" the engine into the stand on rails connecting the two rollover rings, instead of slinging the engine and bolting adapters directly between engines and rings.

After the meeting, the Panel toured the production facilities of the Wright Aeronautic Division, at which plant the meeting was held.

The Tooling Panel is a subsidiary of SAE Committee E-21, General Standards for Aircraft Engines, of the SAE Aircraft Committee.

SAE Representatives To Other Groups Named

AT its most recent meeting the SAE Technical Board confirmed these appointments of its Executive Committee:

B. B. Bachman to succeed G. W. Laurie as SAE representative on ASA Highway Traffic Standards Board, with F. K. Glynn as alternate.

F. R. Nail (Mack Manufacturing Corp.) to serve in an advisory capacity to a new Committee on Uniform Truck Weights and Markings of the Northeastern Conference on Highway Safety and Motor Vehicle Problems, with N. L. Ginder (International Harvester Co.) as an additional advisor.

Peter Altman, Chairman of SAE Small Air-Cooled Gasoline Engine Subcommittee, as SAE representative on ASA Sectional Committee on Safety Standards for Small Air-Cooled Gasoline Engines (such as those used for lawn mowers, etc.), with Gil Buske (Reo) as alternate.

H. D. Wilson (Electric Auto-Lite) as SAE representative on ASA Sectional Committee C40—Storage Batteries, succeeding L. E. Lighton (Electric Storage Battery Co.), resigned due to his retirement.

C. M. Heinen (Chrysler) as alternate to the SAE representative on the ASA Standards Council.

Brooks Short (Delco-Remy) to replace P. J. Kent, who has retired, as SAE representative on ASA Sectional Committee C63—Radio-Electrical Coordination.

Cylinder Liner O-Rings May Need Cold Testing

IF coolant leaks into the oil pan of a wet sleeve engine in cold weather, it may be because the o-ring used to seal the lower end of the cylinder liner takes a set at low temperatures. The cure is to use o-rings that do not take a set at the lowest temperatures encountered.

For this reason, the SAE Non-Metallic Materials Committee and the SAE-ASTM Technical Committee on Automotive Rubber are reviewing low-temperature tests of such o-rings.

Information presented to the committees recently shows that one engine manufacturer faced with the problem is testing o-rings for sealing liners according to the procedure outlined in AMS 3226B, Item F. However, instead of performing the test at 250 F, as the

AMS specifies, the manufacturer performs it at −25 F. The ring is compressed to 70% of original diameter. To pass the test, the ring must return to 85% of its original diameter on release, at the −25 F temperature.

Ride Qualities Studied By SAE for AMA and TTMA

A REPORT on Truck-Trailer Ride Qualities has been prepared by an SAE Subcommittee for the Automobile Manufacturers Association and the Truck-Trailer Manufacturers Association, at the request of the latter two organizations.

The SAE Subcommittee is a joint subsidiary of the SAE Truck and Bus Technical Committee and the SAE Riding Comfort Research Committee.

The information in the report spots the fundamental problems involved in achieving desirable riding qualities in motor freight vehicles and points up engineering approaches to ride improvement. The subcommittee gathered data for the report by observing comparative truck-trailer tests and from studies and researches conducted by its members.

The report has been approved by the Subcommittee, its parent committees, and the SAE Technical Board. It was submitted to AMA and TTMA on May 31.

Easier Maintenance Is Goal of CIMTC Group

EASE of maintenance is the mission of a new subcommittee of the SAE Construction and Industrial Machinery Technical Committee.

The subcommittee has held two meetings. It is working on a frequency schedule and color chart for lubrication. Other lubrication topics scheduled for study in the future include grease fittings and recess holes, a standardized checklist, and quick disconnects and fasteners.

R. W. Beal of the Engineer Research and Development Lab at Ft. Belvoir, Va. is chairman. R. C. Navarin, also of ERDL, is secretary. Members include H. H. Bidwell of Allis-Chalmers, L. Burns of Barber Greene Co., W. C. Burton of Gradall Division of Warner & Swasey, W. P. Edwards of LeTourneau-Westinghouse, A. G. Heisel of Caterpillar, E. Kemp of Euclid, G. Mork of Bucyrus-Erie, A. H. Nolan of the Engineer Maintenance Center, H. V. Parsley of International Harvester. J. Weber of the College of Agriculture of the University of Illinois and H. C. Wuestenberg of Austin-Western are consultants.

Next meeting of Subcommittee XVI —Ease of Maintenance is scheduled for Sept. 10.

Fuels and Lubricants Committee Honors Gjerde

New chairman, Charles Heinen (left), Vice-Chairman David Proudfoot, and M. D. "Doc" Gjerde

ONE of the first official duties Charles Heinen had as new chairman of the SAE Fuels and Lubricants Technical Committee was to present a testament of appreciation to M. D. "Doc" Gjerde, who had been chairman of the committee since 1949. Presentation was made at the Committee's meeting in Atlantic City on June 5.

The framed, hand-lettered resolution shown in the picture reads:

"Whereas, M. D. Gjerde served as a member of the Lubricants Division of the SAE Standards Committee from 1938 to 1947, as Vice-Chairman from 1947 through 1948, and as Chairman from 1949 through 1955 of its successor the SAE Fuels and Lubricants Technical Committee and

"Whereas, both as a member and as Chairman of this important SAE Technical Committee he, by giving freely of his time and energy, by his friendly and conscientious handling of its affairs and by his diplomatic leadership, has rendered an outstanding service to the Society, to the petroleum and automotive industries, and to the motoring public. Therefore be it

"Resolved, that the members of the Fuels and Lubricants Technical Committee join in expressing their appreciation of his services, their admiration for him as an engineer and their affection for him as a fellow member of the SAE."

The change in committee leadership is in line with the SAE Technical Board's desire that committee chairmanships rotate. Gjerde will continue active membership on the committee.

Gjerde is manager of the sales technical service department of the Standard Oil Co. (Ind.). Heinen is assistant chief engineer of Chrysler's Materials Labs, and new Committee Vice-Chairman David Proudfoot is vice-president of Pennzoil.

Filter Test Subcommittee Finalizes Its Procedure for Testing Oil Filters

THE Filter Test Methods Subcommittee has developed its procedure for testing oil filters to the point where it is about ready for standardization.

The basic test set-up is shown schematically in Fig. 1. The test contaminant is circulated continuously throughout the test by a pump in the storage mixer system. Every 8 hr, 800 cc of oil is withdrawn from the sump supplying the filter, item 2 of the sketch. Of this, 40 cc of the oil is analyzed for pentane and chloroform insolubles. The other 760 cc is mixed with 40 g of contaminant stock for an hour, then added to the sump supplying the filter by means of the feeding quadrant, item 9 of the sketch. A pump moves the oil to the filter, and from the filter the oil drains back into the sump.

Each filter element is tested 100 hr. The test contaminants are slurries of concentrated dirt stocks compacted from collected crankcase drainings and mixed with fresh lubricating oil.

The Subcommittee has run several series of cooperative tests totaling tens of thousands of hours of test-running time in order to insure the repeatability and the reproducibility of the results.

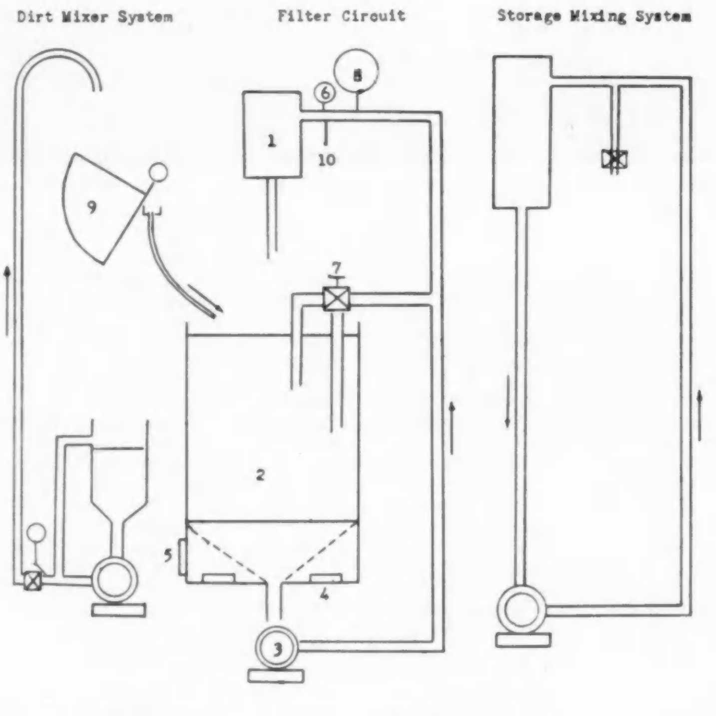
The most recent program of tests showed very good agreement of results among the various laboratories running the tests. Discrepancies in results reported from the preceding series of tests were apparently due to use of a gear pump to agitate the add stock. The gear pump ground the contaminant finer and finer, making it harder for successive filter elements to remove the contaminant. When another type of pump was substituted for the gear pump, it cured the otherwise-unaccounted-for inconsistencies from run to run.

Subcommittee members accepted assignments at a meeting held June 6 in Atlantic City to draft sections of the proposed SAE filter test standard. Expectations are that the work will be edited and ready for consideration by the Subcommittee's parent group, the SAE Engine Committee, and by the SAE Technical Board before the end of the year.

With the job of developing the lubricating oil filter test procedure in final stages, the Subcommittee is now considering future assignments. At its June 6 meeting, it voted to accept an assignment to develop test methods for rating fuel filters for diesel and gasoline injection systems. Subcommittee Chairman R. J. Pocock appointed a panel to plan the work. Its members are S. L. Earle, chairman; F. P. Babcock; H. T. Parrett; and F. C. Koch.

Also on the list of possible future projects is an investigation of oil filtration in which heavy duty oil is involved. With the changing nature of additives and resulting changes in oil properties, there is a tendency toward decreased formation of sludge beds on filter surfaces. This may call for restudy of the filtration process, the Subcommittee feels.

Current membership of the Subcommittee includes R. J. Pocock of Ford, chairman; F. C. Koch of Detroit Arsenal, secretary; R. L. Bowers of AC Spark Plug; S. L. Earle of U. S. Naval Engineering Experiment Station; J. R. Farnham of Chrysler; K. E. Humbert, Jr. of Wix Corp.; H. G. Kamrath of Fram Corp.; H. R. Otto of Purolator; and S. J. Puglisi of Cuno Engineering Corp.



1—test filter
2—oil sump
3—pump
4—heating unit
5—thermostat
6—thermometer
7—pressure regulating valve
8—pressure gage
9—feeding quadrant
10—sample port

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NEWS OF SAE

Participation, Flexibility, Continuity Are Big Words in

PLANNING FOR PROGRESS

R. J. S. Pigott, Chairman

SAE Planning for Progress Committee

EXAMINING ideas and suggestions for improving the Society structure, the Planning for Progress Committee has come to feel that three qualities of SAE's current organization must be preserved and enhanced. They are:

1. **Participation**: SAE's strength depends on getting as many as possible of its members engaged in Society work . . . contributing to and receiving from this participation. Only from participation does a member get to feel that he's an integral part of SAE.
2. **Flexibility**: It's highly important that our SAE structure be sufficiently flexible to absorb new or changing technical needs of our members and to produce services that will satisfy these needs.
3. **Continuity**: Our Society's administrative structure should be so designed as to produce a proper blending of knowledgeable men, experienced in handling and leading SAE affairs, with new men who have demonstrated the aptitudes eventually to take up the reins.

These concepts are, perhaps, the chief areas in which the Committee's thinking has so far moved into fairly clear focus. At its June 3rd Atlantic City meeting, it continued to explore various other areas, after getting a report from Committeeman Leonard Raymond of his study forecasting the growth of the Society.

Raymond's figures, which grew out of published data projecting increase in population, national gross products, and industrial and research development, forecast a Society membership of 35,000 to 50,000 by 1975. Agreeing that these were probably conservative figures, the Committee felt that SAE has an obligation to serve the technical information needs of automotive engineers, whatever their number. As more men enter the field, the Society must be prepared to extend its services to them.

Section-National Society Relationships:

Leonard Raymond suggested also that consideration might be given to a greater tie-in between the Sections and the national Society. He feels that the Sections can contribute more than at present to the overall operation of the Society, both technically and administratively.

For instance, it might be possible to have technically knowledgeable Section representatives serve on Activity Committees. Perhaps similar tie-ins might be developed in other areas. Such a plan might furnish a smooth transition of members from Section operations to national Society work.

The Committee agreed that this kind of thinking appears to have much merit and should be examined more fully as the Committee's study progresses.

Technical Board Features Examined:

President Delaney had suggested that the Technical Board offers features applicable to other Society operations. A general discussion of this thought brought out the fact that the Technical Board furnishes to a high degree the three qualities mentioned above . . . participation, flexibility, and continuity.

The Committee examined the possibility of a similar Board to

SAE Seeks More

A group of interested SAE members met informally on June 4 in Atlantic City to discuss ways and means of bringing to the Society more of the latest engineering information that is being developed in foreign countries.

Keynoting the "conversations," Past-President C. G. A. Rosen—who has been invited by President Delaney to head the project—suggested that "good engineering recognizes no national boundaries." There are untapped sources of original engineering ideas and practices in foreign countries that would be informative and useful to SAE members.

The value of such information has been amply demonstrated many times throughout the years of SAE meetings. The papers presented by lecturers such as Sir Harry Ricardo and Dr. J. S. Meurer at the Golden Anniversary Summer Meeting are among more recent examples.

During the past three years there have been 32 papers presented before SAE national meetings from overseas sources. However, it was felt that more technical material should be made available and that perhaps other means, in addition to national meetings, could be used to disseminate this information to SAE members.

The 18 SAE members who took part in the informal discussion in Atlantic City advanced ideas and suggestions from their own experiences and knowledge of engineering operations overseas. In general, they felt that:

1. Any technical information that is gathered from overseas should be of practical help to SAE members and be worth the effort expended to get it.

head up the work of the Professional Activities. Such a Board could be distinguished from the Technical Board in that:

- The "Activity" Board would operate to serve the technical information needs of individual members.
- The Technical Board (as it is now organized) serves the technical needs of industry through cooperative technical work.

The Committee further pursued this thought and reflected on the make-up of Council. It was thought that Council might well consist of (1) men who are competent in the technical or engineering aspects of the Society's business, and (2) men competent in the Society's administration. Although the present Council is largely made up of representatives of the 12 professional areas, the Committee agreed that Council members should not be representatives of any particular group. They should serve the interests of the entire Society membership.

Next meeting of this Planning for Progress Committee is scheduled for Milwaukee during the 1956 SAE Tractor Meeting in September.

Nuclear Data Entering SAE Technical Channels

C. R. Lewis, Chairman

SAE Nuclear Energy Advisory Committee

CARRYING on the work started by A. L. Pomeroy as a committee-of-one in 1955, the now three-man Nuclear Energy Advisory Committee sees itself as the eyes and ears of SAE on things nuclear. At the request of SAE President, George A. Delaney, it has accepted responsibility for feeding to the membership atomic information of interest to automotive engineers, using all of SAE's available information-disseminating tools (such as meetings, SAE Journal, and other publications).

Nucleareas

To equip itself for this task, the Committee has already started to explore those aspects of nuclear energy on which SAE members seem likely to want to keep posted. The group has agreed that it should keep close tabs on:

a. Nuclear propulsion of motor vehicles, aircraft, and railroad locomotives.
b. Use of nuclear radiation in processing materials such as fuels, lubricants, plastics, and metals.
c. Industrial applications of radioisotopes.

Dr. L. R. Hafstad has pointed out and Dr. A. A. Kucher and the Chairman agree that if the Committee is to cover so broad a field, additional members should be added who normally are tuned in with these various nuclear fields. The Committee has discussed the special areas from which it might draw its additional members and agreed on the possibility of a nuclear specialist from

Please turn page

Technical Information from Overseas

2. The information gathered should be "automotive" in the broadest sense; i.e., it should apply to the traditional areas of SAE engineering interest and to possible future interests such as nuclear energy, electronics and guided missiles.

3. The mechanism for obtaining overseas information should be kept flexible and informal at first so that devices and procedures can evolve as the program is gotten underway.

It was suggested that the kind of information of most use to SAE members is "interpretive engineering," the story of how an engineering problem was met and solved, reasons for designs and solutions, trends, and new theories. Particularly at the start of this Overseas Information Project, SAE is interested in new engineering principles and ideas that will provide a base on which to present descriptions of new products later.

It was felt that a primary source of this kind of engineering information may be any of the SAE members whose engineering business:

a. Takes them abroad frequently, or
b. Tends to keep them in more or less regular contact with foreign companies and engineers in the areas of their own technical interests.

In addition, the group discussed the possibility of establishing contacts in foreign countries—especially Europe—that could feed new information to the SAE through the established channels in the 12 SAE professional Activities. SAE members who are now living overseas would be logical overseas correspondents for this phase of the project.

Dr. Rosen requested from those present at the discussion, and from any SAE member, specific suggestions for speakers, papers, and subjects which would be of interest to the Society.

The group which met in Atlantic City will probably be called together again during the 1957 Annual Meeting in Detroit to continue exploring the possibilities of enlarging SAE's overseas activities. Those present at the meeting were: G. A. Delaney, SAE President; C. G. A. Rosen, Advisor to the President on Overseas Information; R. R. Burkhalter, Dana Corp; W. Paul Eddy, Pratt & Whitney Aircraft Division, United Aircraft Corp.; E. F. Gibian, Thompson Products, Inc.; R. D. Speas, Aviation Consultant; M. A. Thorne, General Motors Corp.; and F. P. Zimmerli, Associated Spring Corp.

each of the following fields:

a. The petroleum industry.
b. The railroads.
c. The aircraft engine field.
d. University research.
e. The chemical industry.

Committee members have been asked to give some further thought to additional names.

Committee Plans

One of the Committee's jobs will be to act as a reporting agency on nuclear developments. Such reports, the Committee agreed, could grow out of meetings attended by the members as well as literature and reports they read as specialists which in their estimation would prove interesting to SAE members.

The Committee also agreed to present to the SAE Journal for publication a list of recommended reading in the nuclear field. Dr. Hafstad believes this could prove a real service since there is a raft of literature appearing in the field; and it's difficult for engineers to do an intelligent selection themselves without spending an unnecessary amount of time in scanning much of the printed material.

The Committee will meet at least twice each year . . . at the Annual and Summer Meetings, but its members will meet on an informal basis more frequently.

SAE Service to AEC

In 1953, SAE participated with the Atomic Energy Commission and the Federal Civil Defense Administration in evaluating the effects of an atomic explosion on passenger cars. When this work was done, the Society created a technical committee to take part in a test explosion at Yucca Flats, Nevada. The SAE group studied the effects of the atomic blast on test vehicles and reported its findings and conclusions to the Government groups involved.

The Committee has agreed to recommend to the SAE Technical Board that the Board offer its services to the Atomic Energy Commission on any similar projects where SAE's comparative technical work could assist the AEC in its operations.

1957 Nuclear Engineering and Science Congress

President Delaney has received an invitation from the Engineers Joint Council asking the Society to participate in the 1957 Nuclear Engineering and Science Congress, March 10–16, 1957. (SAE was one of the 26 Societies that participated in the first Nuclear Engineering Congress in Cleveland last December.)

The Committee felt that it would be wise for SAE to accept the invitation since it would provide an opportunity for keeping in touch with nuclear developments. The Committee has asked its Chairman to represent SAE on both the General Committee and the Program Committee for the '57 Nuclear Engineering Congress. The appointment has been made by President Delaney.

ASA Activity in the Nuclear Field

At a meeting of the Standards Council of the American Standards Association on Friday, June 1, the Standards Council voted to embark on standards for the nuclear fields. A Nuclear Standards Board was approved and several Sectional Committees under it set up.

The Society's representative at this meeting voted against this proposal. It was his feeling that it was too premature to establish costly machinery for standardization in a brand new field when the needs for standards were not as yet clearly defined. He also noted at the meeting that standards as he understood them *follow* practice . . . and that the ASA action seemed to constitute standardization *preceding* practice.

Although the SAE representative was in the minority in voting against the proposal, the Committee went on record as endorsing the stance taken by him at the Standards Council meeting on nuclear standards. (This recommendation was made to SAE Council by the Chairman, on behalf of the Committee. The Council approved the Committee's recommended stance at its meeting on June 7.)

SAE National Meetings

1956

September 10-13
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 2-6
Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 10-12
Transportation Meeting
Hotel New Yorker
New York, N. Y.

November 1-2
Diesel Engine Meeting
The Drake, Chicago, Ill.

November 8-9
Fuels and Lubricants Meeting
The Mayo, Tulsa, Okla.

1957

January 14-18
Annual Meeting and Engineering Display
The Sheraton-Cadillac and Statler Hotels,
Detroit, Mich.

March 5-7
Passenger Car, Body, and Materials Meeting,
The Sheraton-Cadillac,
Detroit, Mich.

March 20-22
Production Meeting and Forum, Hotel Statler,
Buffalo, N. Y.

April 2-5
Aeronautic Meeting,
Aeronautic Production Forum,
and Aircraft Engineering Display
Hotel Commodore, New York, N. Y.

June 2-7
Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, N. J.

August 12-14
West Coast Meeting
Olympic Hotel, Seattle, Wash.

September 9-12
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee, Wis.

SAE National Tractor Meeting and Production Forum

Hotel Schroeder **Milwaukee, Wis.** **Sept. 10-13, 1956**

Bring your problems; share your knowledge at SAE's

Tractor Production Forum
Sept. 10-11

Sponsor: **F. S. Mackey**, A. O. Smith Corp.
Gen. Chr.: **S. K. Rudorf**, A. O. Smith Corp.

Monday, Sept. 10

morning: three simultaneous panels on Tools, Heat-Treatment, and Management Control

afternoon: three panels on Quality Control, Perishable Tools, and Automation

Tuesday, Sept. 11

morning: three panels on Cost Reduction, Gears and Splines, and Plant Communications

Discover tractor design trends at SAE's

Tractor Meeting
Sept. 11-13

Gen. Chr.: **G. Y. Anderson, Jr.,** Bucyrus-Erie Co.

Tuesday, Sept. 11

Winterization of Construction Equipment
The Wide-Base Tubeless Tire
Cerametallic Friction Material

Wednesday, Sept. 12

Mechanical Gear Testing
Adapting Industrial Equipment to the Agricultural Tractor

Thursday, Sept. 13

Recent Developments in Tractor Hitches
Nebraska Tractor Test Changes
Future Fuel Trends in the Farm Tractor Field

Special Events

Monday, Sept. 10 and Tuesday, Sept. 11

Lunch: A. O. Smith Corp.'s Exhibit Hall, courtesy of **F. S. Mackey**

Wednesday, Sept. 12

Lunch: Empire Room, **S. C. Heth,** Chr.
E. Blyth Stason, Dean, University of Michigan Law School
"The Atom in Industry and the Law"

Friday, Sept. 14

SAE Milwaukee Section's Annual Golf Tournament

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Fred E. Stockwell .... Vice-Chairman
New Haven
Walter J. Gewinner .. Vice-Chairman
Springfield
Roy B. Fisher .... Treasurer
Arnold D. Nichols .... Secretary
Address of Secretary—29 Gilbert Dr., Newington, Conn.

Spokane-Intermountain

John L. Peters .... Chairman
Lewis J. McBride ..... Vice-Chairman
Orville B. Isaacs .... Treasurer
J. G. Critzer .... Secretary
Address of Secretary—Box 152, Spokane, Wash.

Syracuse

Alfons Alven .... Chairman
Edward F. Hannon ... Vice-Chairman
Albert H. Winkler, Jr., Vice-Chairman
Elmira
Glen H. Dingman .... Vice-Chairman
Sidney
Robert W. Wolfe .... Treasurer
Lloyd L. McArthur .... Secretary
Address of Secretary—116 Pine Tree Dr., North Syracuse, N. Y.

Texas

J. T. Hurry .... Chairman
Sam R. Billingsley .... Vice-Chairman
Lloyd J. Wolf .... Treasurer
Herbert M. Gaebe .... Secretary
Address of Secretary—Chance Vought Aircraft, Inc., Box 5907, Dallas, Texas.

Texas Gulf Coast

Louis F. Mock, Jr. .... Chairman
R. Frank Wilson ...... Vice-Chairman
William H. Fain ...... Vice-Chairman
Diesel Engine
William C. Steen .... Vice-Chairman
Fuels and Lubricants
Ben F. Denny .... Vice-Chairman
Production
Harris Saunders, Jr. .. Vice-Chairman
Transportation and Maintenance
Learon R. Shankle ... Vice-Chairman
Truck and Bus
Charles F. Goff .... Treasurer
William B. Tilden .... Secretary
Address of Secretary—Texas Co., Sales Department, 720 San Jacinto St., Houston 1, Texas.

Twin City

S. H. Knight .... Chairman
Donald D. Hornbeck .. Vice-Chairman
Donald L. Van Orman ..... Treasurer
Albert L. Preston .... Secretary
Address of Secretary—Minneapolis-Honeywell Regulator Co., Aero Division, 2600 Ridgway Rd., Minneapolis, Minn.

Virginia

Robert C. Seavers, Jr. ..... Chairman
J. Van R. Kelly ...... Vice-Chairman
Charles W. Galloway ...... Treasurer
R. W. Duffer .... Secretary
Address of Secretary—Martin Chevrolet Sales Corp., 2805 W. Broad St., Richmond, Va.

Washington

Harold D. Hoekstra .... Chairman
Lewis C. Kibbee ...... Vice-Chairman
Robert J. Auburn .... Vice-Chairman
Aircraft
J. Chase Fielding .... Vice-Chairman
Engineering Materials
Charles P. Hoffman, Jr. Vice-Chairman
Transportation and Maintenance
Ivison W. Rhodes, Jr. ...... Treasurer
Charles H. McDonnell ...... Secretary
Address of Secretary—George Armistead & Co., 1200 18th St., N. W., Washington 6, D. C.

Western Michigan

Bernard E. Ricks .... Chairman
Bine W. Rollin ...... Vice-Chairman
Earle J. Seward ...... Vice-Chairman
Grand Rapids
Herman F. Stapel .... Treasurer
Arling H. Jensen .... Secretary
Address of Secretary—Sealed Power Corp., 2001 Sanford St., Muskegon, Mich.

Wichita

Charles Y. Allison, Jr. ..... Chairman
Robert G. McKay .... Vice-Chairman
Jay H. Whoolery .... Treasurer
William W. Hurtt .... Secretary
Address of Secretary—426 S. Roosevelt, Wichita 8, Kans.

OFFICERS OF SAE GROUPS

1956-1957

Alberta

Frederick G. Forster ...... Chairman
John G. Bruce .... Vice-Chairman
Henry J. Rasmussen .... Treasurer
Francis Price .... Secretary
Address of Secretary—303 Hendon Dr., Calgary, Alberta, Canada.

Colorado

William A. Nestlerode ..... Chairman
Paul G. Anderson .... Vice-Chairman
Forrest E. McGrath .... Treasurer
Robert R. Atchison .... Secretary
Address of Secretary—15 Newton St., Denver 19, Colo.

Salt Lake

William P. Barnes .... Chairman
Leonard J. Giacomozzi Vice-Chairman
Jay P. Bywater .. Secretary-Treasurer
Address of Secretary—J. P. Bywater's Industrial Service, 564 Elizabeth St., Salt Lake City 2, Utah.

South Texas Effective Oct. 1, 1956

Ludwig L. Motulsky .... Chairman
Herman J. Pomy ..... Vice-Chairman
Leo Dubinski .... Treasurer
George C. Lawrason .... Secretary
Address of Secretary—819 Rittiman Rd., San Antonio 9, Texas.

Williamsport

Allen Weiss .... Chairman
Frank W. Riddell .... Vice-Chairman
Paul Cervinsky .... Treasurer
Harry J. Lavo .... Secretary
Address of Secretary—435 Market St., South Williamsport, Pa.

SECTIONS

AUGUST 1956

Sections Set Fine Record As How-We-Do-It Reporters

84 pages of SAE Journal have been devoted to Section operations since the new Journal program which emphasizes trade of useful ideas and information on the performing of basic and special Section activities went into effect in November, 1955. 82% of the Sections and Groups have played an active part in this new program. Journal Field Editors have offered proof that Sections welcome the opportunity to exchange How-We-Do-It information.

Section members have shown their enthusiasm first of all by appointing active, interested Field Editors. They have chosen men who recognize the value of contributing to the Section Governing Board's effort to effectively execute the Society's basic aim—exchange of technical information. They have gone to work as sleuths, uncovering activities and procedures that have been most effective and therefore have made the Sections most proud.

Accomplishing this function has often required mustering help from Governing Board members and committee chairmen. A story directly from the man who knows packs a wallop.

Right here is the second way Section members have shown their enthusiasm. Cooperation of Section officers and committee chairmen has been tops. SAE Journal has been proud to give these men credit for their help.

One particularly effective form of contribution from committees has been the complete picture story of a special Section function and its development from mere idea, such as the picture story from Southern California Section on its Mac Short Award on page 82. In this case, the Field Editor, Student Activity Committee, and Student Branch members themselves worked together to provide How-We-Do-It facts for Journal readers.

But there is still a third way that SAE members have backed up this new program. More technical papers from Section speakers have found their way into headquarters for treatment in the technical pages of SAE Journal than ever before. This has served a twofold purpose. It has given each speaker the recognition he deserves and it has credited each Section with the speaker's talk.

These accomplishments are not small. Continuing contributions to each month's SAE Journal make them larger and larger.

Central Illinois

Harlan Banister, Field Editor

A revision of the list of duties of Central Illinois Section officers and Governing Board members is being prepared in order that the 1956–1957 and subsequent Governing Boards will have an accurate description of the duties they are to perform.

KANSAS CITY

H. H. Hart, Field Editor

Grandview Air Base officers led 40 SAE members and guests on an inspection tour on May 8. The group saw the Combat Operations Center, 20th Air Division, link trainer and crash rescue equipment in the Fire Station, and the flight simulator and readiness building of the 326th Fighter Interceptor Squadron.

CINCINNATI

H. E. Pitzer, Field Editor

Everett C. Lindsey, personnel director, Gulf Oil Co., spoke on "Motivation" at the May 28 meeting of the Cincinnati Section.

After dinner speaker was Raymond E. Clift, executive director, Greater Cincinnati Safety Council, who spoke on "Fatal Fallacies of our Automotive Age."

Mid-Michigan

G. W. Colby, Field Editor

Section Ticket Chairman Solves Ticket Detail Problem

Ticket distribution, a nagging problem in many Sections, is no longer a burden to RUSS MARTZ, Mid-Michigan Section Ticket Chairman. Martz has ironed out ticket distribution problems by getting the help of the Membership and Plant Representative Committee.

The Mid-Michigan Section has 14 Representatives in five cities. These men are responsible for the actual sale of tickets and are always alert to the possibility of increasing SAE membership.

Two weeks prior to a meeting, the Advertising Chairman mails tickets and programs to the Ticket Chairman for distribution. Upon receipt of the tickets and programs, they are allocated to all Plant Representatives in proportion to past sales record. It is very important that all Representatives contact the Ticket Chairman not later than noon on Friday, with an estimated attendance for the following Monday's meeting. Tickets are also reserved at this time for "At Large Members" who are not directly represented.

Arrangements Committee

The Arrangement Committee is notified of the estimated attendance and they in turn, contact their prearranged caterer to confirm reservations. Any ticket reserved or sold after Friday noon is at an increased rate.

Ticket money is collected from Representatives just prior to program time. Checks for total sales from the Representatives are encouraged. The money is turned over to the treasurer as soon

So. California

W. E. Achor, Field Editor

The Story of the **MAC**

Presentation of the Mac Short Award at the May dinner meeting for the best Student Technical Paper culminates a busy year for 1955–1956 Student Activity Chairman Thomas H. Hardgrove.

2. Preparation began early in the SAE year when Tom Hardgrove sat down with faculty advisers and student chairmen to select students to represent the schools in the contest. He is shown (center) explaining contest procedures with **Cal Poly Faculty Adviser Joy Richardson** (left) and **Cal Poly Student Branch Chairman George Wedemeyer** (right).

3. Last minute instructions and encouragement are given participants before they present 10 minute summaries of their papers before the Governing Board. Copies have been distributed for preliminary evaluation. Left to right are **Peter Kyropoulos**, former Student Activity chairman; **Hardgrove; Jan Arps**, Cal Tech; **J. E. Bartley**, Cal Poly; and **Bill L. Coffey**, Northrop Institute.

as accounts are settled. A complete report of all ticket sales, itemizing number of Members—Student Branch members—Guests—and Complimentary tickets, is made out and mailed to the Section chairman, secretary, and treasurer after each meeting. All ticket stubs are mailed to the secretary after the itemized report is complete.

Between programs, the ticket chairman turns over to the Publicity Committee any notice of change of address.

Attendance Grows

In addition to reporting a solution to ticket distribution problems, Mid-Michigan Section also reports that attendance is very encouraging. Last season an average of 45% of the members attended Section meetings. This is the highest of any Section of equal or larger membership. With an eye to the future, Mid-Michigan has elected to subsidize the Student Branch members in order to encourage their attendance.

Cooperation

According to Martz, the Representatives did an excellent job this year and the Section can be mightly proud of their record. He feels that his duties were lightened further by the wonderful team cooperation of all the members, governing Board, and Committee chairmen.

CHICAGO

P. P. Polko, Field Editor

Aeronautical University Student Branch joined with IAS student members for a trip through Standard Oil Co., Whiting, Ind., on May 29. The group was conducted through the refinery to observe crude distillation, sweetening operation, catalytic and thermal cracking, lube oil treating, phenal extraction, and motor oil blending units.

SHORT AWARD

1. Hardgrove's responsibility was to set up and carry through a technical paper contest between members of the California Institute of Technology, California Polytechnic Institute, and Northrop Aeronautical Institute SAE Student Branches, for possession of the Mac Short Memorial Award Trophy held at right by **Mrs. Mae Short**, sponsor, and her son, **Dick**.

4. **Bill Coffey** is caught illustrating his summary of "Dynamic Braking Device for Recovery of Ballistic Type Guided Missiles." Jan Arps condensed his paper on "Black Gold from the Blue Sea" and John Bartley summarized his paper on "Cam Design for Maximum Output and High RPM."

5. Tom congratulates winner Bill Coffey and thanks the other participants for their efforts. Certifications were awarded to Jan Arps and John Bartley to acknowledge their participation in this contest. Left to right are **Jan Arps, Bill Coffey, Tom Hardgrove,** and **John Bartley.** The Mac Short Memorial Award Trophy won by Bill Coffey for Northrop Aeronautical Institute Student Branch will be retained by that school until next year's contest decides the next year's possessor.

From Section Cameras

1. **Alberta Group's** immediate Past-Chairman **C. Standen** (left presents the past-chairman's certificate to **1955–1956 Chairman Harry Dawson.**

2. **Central Illinois Section Chairman R. V. Larson** is shown with **Milt C. Neul**, Technical chairman, and Section members who presented papers at the May 28 "Home Talent" meeting. Left to right are: **R. V. Larson**; **Milt C. Neul**; **Ed Echer,** who presented a paper entitled: "Fastener Stresses"; **Ralph Clark**, whose paper was entitled: "Earthmoving Equipment Transmissions—Where Are We Going?"; and **R. C. Barns,** whose paper was entitled "Designing for Strength."

3. Newly elected and past chairmen of the **Milwaukee Section** are shown with their wives at the annual Ladies' Night party held on June 9 at the Ozaukee Country Club. Left to right are: **Past-Chairman Igor Kamlukin,** Mrs. Kamlukin, Mrs. Myers, and **1956–1957 Chairman Phillip S. Myers.**

Section Briefs

Has your Section had a group sing yet? **Alberta Group** reports special success with this form of entertainment. Who knows, maybe some quartets will spring up.

Ladies' Night has been reinstated in **Kansas City's** program schedule. The May 8 celebration was the first Ladies' Night in several years.

Bob Larson, **Central Illinois Section's** 1955–1956 chairman, has this to say: "The spirit of cooperation is one of SAE's outstanding features. I am proud that it has been strongly evident in Central Illinois Section this year."

Montreal Section members like to play golf. They got together for a Section tournament on June 29.

Matched Studies Reveal Turboprop Differences

Based on paper by

ELMER H. DAVISON

National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory

TO get a better understanding of turboprop engines, matched studies of three types—single-spool, two-spool, and free-turbine—were made for flight conditions ranging from sea-level-static to flight at 600 mph and 40,000 ft. From these studies the following conclusions were drawn:

1. An adjustable exhaust-nozzle area is desirable. It makes the turbine frontal area, stress, and pressure ratio requirements less critical without penalizing engine performance.

2. The specific fuel consumption of the engine depends primarily on flight condition and turbine-inlet temperature, with the mode of operation having a secondary role. The lowest specific consumption is obtained at full power or maximum turbine-inlet temperature and at the highest flight velocity and altitude.

3. A single-spool engine has less critical turbine design requirements than a free-turbine engine.

4. For the flight conditions considered, the free-turbine is restricted in the range of turbine-inlet temperature over which it can operate if adjustment of the stator areas is not permitted.

5. Nearly minimum specific fuel consumption and operation over a wide range of turbine-inlet temperature were obtained for a two-spool engine without turbine stator adjustment if the compressor pressure ratio of 12 was split 6-2 (outer-compressor pressure ratio of 6 and inner-compressor pressure ratio of 2).

6. It was necessary to adjust at least the outer turbine stators of a 2-6 two-spool engine to get the fuel economy and range of turbine-inlet temperature possible in the 6-2 engine without stator adjustment. With such an arrangement the 2-6 engine has much more critical turbine design requirements than the 6-2 engine.

7. Increasing the outer-compressor pressure ratio of a two-spool engine results in characteristics similar to the single-spool engine, while reversing the split results in characteristics similar to the free-turbine type.

(Paper "Compressor and Turbine Matching Considerations in Turboprop Engines" was presented at SAE Annual Meeting, Detroit, Jan. 13, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

CONTINUED ON PAGE 106

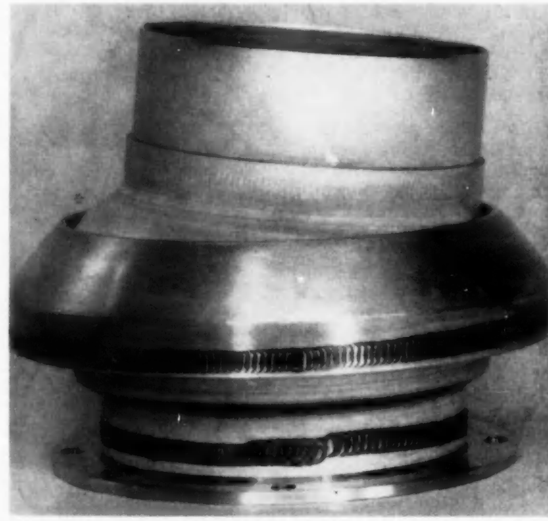


Fig. 1—Ball joint developed for aircraft ducting system. It is designed to accommodate thermal growth and relative motion without impairing the basic tension-carrying quality of the duct. All-metallic construction gives it excellent temperature resistance.

Special Joints Aid Aircraft Ducting

Based on paper by K. W. GOEBEL Rohr Aircraft Corp.

A NUMBER of mechanical joints have been developed to solve the problem of ducting high-pressure, high-temperature air through an airplane nacelle with negligible leakage. One of these units is a ball joint shown in Fig. 1.

A series of these ball joints can be incorporated into a duct system to accommodate thermal growth and relative motion without impairing the basic tension-carrying characteristics of the duct. Operational security is sound since no working of the basic material is involved in the function of the part. Temperature resistance is excellent because the joint contains no non-metallic element. Any failure is related to leakage characteristics and is discernible as a progressive indication which normal inspection will reveal. Ultimate service life of these joints has yet to be determined but production parts now in operation are accumulating an appreciable number of service hours with no apparent loss of function or efficiency.

Detail configuration of a particular duct system may require provision for length change in a straight run. Hence an axial slip joint has been developed which can accommodate lineal duct changes of large or small magnitude. This slip joint can be used in combination with the ball joint to provide a completely flexible joint.

Since the application of a single slip joint will result in a break in the continuity of the duct system, provision should be made at its point of application to carry the resultant end loads. Since in some cases these end loads cannot be readily accommodated, a compensated slip joint has been developed. Here again, the slip joint can be used in combination with the ball joint to provide a completely flexible joint retaining the tension-carrying ability of the basic duct.

These assemblies exhibit excellent sealing qualities with maximum leakage at pressure and temperature being in the order of 0.002% of the total duct flow. They contain no non-metallic elements. Hence they have excellent temperature resistance. (Paper "Compressor Bleed Ducting for Auxiliary Power Supply" was presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

About SAE Members

Pulver

Branson

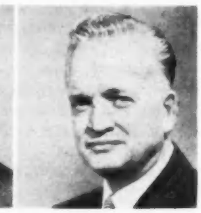
Glynn

Chapman

Jarosz

Anderson

Lombard



Warden

W. A. PULVER, chief manufacturing engineer of the California Division of Lockheed Aircraft Corp., has been named assistant chief engineer of the company's Georgia Division at Marietta. The announcement was made by **R. W. MIDDLEWOOD**, chief engineer of the Georgia Lockheed Division.

CHARLES D. BRANSON, formerly chief engineer at Robertshaw-Fulton Controls Co. in the Fulton Sylphon Division, Knoxville, Tenn., has been appointed assistant director of research in that company with offices at the Robertshaw Research Center at Irwin, Penn.

F. K. GLYNN retired from American Telephone & Telegraph Co. as automotive engineer on Aug. 1. He had been with A.T.&T. since 1925.

His immediate plans include short duration consulting jobs, but for the most part he "will do the 101 things I've never had time to do."

"K", as he is known to his friends, has maintained a full schedule of SAE committee activities for many years. He will continue this activity, with modifications. In 1926–1927 he served as chairman of Metropolitan Section. He was vice-president representing Transportation and Maintenance in 1931 and served as a Councilor in 1938–1939. Some of his committee work has been with the Brake Committee, the Fuels and Lubricants Technical Committee, the Transportation and Maintenance Activity Committee, and as an SAE representative on the ASA Standards Council.

He will be succeeded as automotive engineer at A.T.&T. by **GEORGE E. KELM**, who has been superintendent of motor equipment for Michigan Bell Telephone Co.

B. A. CHAPMAN has been elected vice-president in charge of operations for American Motors Corp. Announcement was made by **GEORGE ROMNEY**, president of American Motors.

Chapman, formerly vice-president and general manager of the Kelvinator Division, will continue also as chairman of the Appliance Division's operating committee.

CLARENCE A. JAROSZ has been appointed general service manager, Bendix-Westinghouse Automotive Air Brake Co., Elyria, Ohio. It is a newly created position in which he will direct the activities of the general service group to manufacturing accounts, and field and technical service to distributors and operators.

Jarosz joined Bendix-Westinghouse in 1947 as a production planner. His most recent post was distributor sales manager and technical service manager.

R. E. COUGHENOUR, a regional manager for Bendix-Westinghouse, has been made regional service sales manager for the central region.

W. H. PARISH, JR., also a regional manager, has been named regional service sales manager in the southern region.

MARVIN R. ANDERSON is the newly elected president of Michigan Tool Co. He succeeds **OSCAR L. BARD** who has been elected chairman of the board of that company.

Anderson, son of one of the founders of Michigan Tool, has been with the company since 1935. He has been executive vice-president for the last 12 years. For the last year, Anderson has also been president of the American Gear Manufacturing Association.

Bard has served as president of Michigan Tool Co. since 1940. He started with the company 40 years ago.

DR. ALBERT E. LOMBARD, JR. has been made director of research at the recently established Research Department of McDonnell Aircraft Corp. in St. Louis. Lombard will head a department which will be concerned with problems of applied science and engineering research.

Dr. Lombard, comes to McDonnell from the Directorate of Research and Development, U.S.A.F.

H. H. WARDEN has been appointed Link Aviation, Inc.'s commercial sales manager in charge of sales of flight simulators to the air transport industry.

Warden joins Link after 15 years with the Curtiss-Wright Corp. His last five years at Curtiss-Wright were as general sales manager of the Propellor Division at Caldwell, N. J.

ALFRED P. SLOAN, JR. has resigned from the position of chairman of the board of General Motors Corp. Sloan will remain a member of the board and has been elected honorary chairman. He will also continue as a director, a member of the financial policy committee, and as chairman of the bonus and salary committee.

Sloan has been chairman of the GM board of directors since 1937. He was chief executive officer for 23 years.

ROGER M. KEYES, former Deputy Secretary of Defense and now a vice-president and director of General Motors Corp., has received the Air Force's Exceptional Service Award. It is the highest Air Force award presented to civilians.

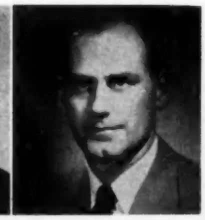
H. M. HORNER, president of United Aircraft Corp., has been elected chairman of the board. He also retains the position of chief executive officer.

ALBERT R. GRIESBACH, formerly a projects and methods engineer with Tinnerman Products, Inc., is now vice-president of the Elmer C. Cook Co. of Cleveland.


Mudge


Burchfield


Doe


Burns


Isbrandt


Berry


Rourke


Parmet


Keen


McMillan


Naumann


Hess

R. H. ISBRANDT, executive engineer, has been appointed director of engineering for American Motors Corp., as announced by **MEADE F. MOORE,** vice-president of automotive engineering and research.

Isbrandt was named executive engineer early this year and was previously chief design engineer for the company's automotive division since 1953.

Moore also announced the appointment of **WALLACE S. BERRY** as director of research for the automotive division. Berry, who has been the division's chief mechanical engineer, previously held the same post with Nash Motors since 1946 when he helped organize the department.

RUSSELL K. ROURKE, formerly manager of aircraft economic analysis, has been named director of engineering research at Trans World Airlines Inc. Rourke, who attended Kansas University from 1933 to 1937, worked as a service engineer for Pratt & Whitney Division of United Aircraft Corp., during the war, joining TWA in 1945.

He is a past SAE Kansas City Section vice-chairman of aeronautics, a member of the SAE Air Transport Activity Committee, and a member of the International Air Transport Association Technical Committee.

NORMAN R. PARMET, formerly supervisor of power plant engineering, is now director of aircraft development for TWA. He is currently chairman of the SAE Kansas City Section.

Parmet, a bomber pilot in World War II, obtained his engineering degree from Drexel Institute of Technology, Philadelphia, in 1947. He joined TWA that same year at Newcastle, Del., transferring to Kansas City in 1949.

W. NEWLIN KEEN is the new assistant manager of the Akron districts sales office of the Elastomers Division of E. I. du Pont de Nemours, Inc. at Chestnut Run Del. Keen has been with du Pont since his graduation from college in 1941. In 1953 became chief engineer of the Elastomers Laboratory at du Pont's new technical sales service center.

WILLIAM D. McMILLAN, supervisor of metallurgy for the Farm Implement Division of International Harvester Co., has been awarded an Honorary Life Membership in the American Foundrymen's Society. He has been honored ". . . for outstanding contributions to the Society and the ferrous castings industry."

McMillan joined Harvester 33 years ago. In 1949 he was appointed to his present position.

GARNET P. PHILLIPS has been elected a director of American Foundrymen's Society for a three-year term. Phillips is general supervisor, foundry research, International Harvester Co., Chicago.

DR. W. A. MUDGE has been appointed special representative on educational programs of the International Nickel Co. of Canada, Ltd. and its United States subsidiary, the International Nickel Co., Inc. Mudge has been director of the technical service section of the Development and Research Division.

Mudge joined International Nickel in 1920 as a member of the Research Department at the company's Bayonne Works in New Jersey. He has served successively as superintendent of research, superintendent of the refinery, and works metallurgist at Inco's Huntington Works in West Virginia. In 1939, he was transferred to the company's Development and Research Division in New York, first as assistant director and then as director of the technical service section.

WILLIAM F. BURCHFIELD is the newly appointed supervisor of technical service in the International Nickel Co.'s Development and Research Division. Burchfield has been serving since 1947 as assistant director of technical service under Mudge.

THOMAS B. DOE, JR. has been named manager of export sales for Vickers, Inc. In his new position, Doe will be responsible for consolidation of all export sales activities involving aircraft, industrial, and mobile equipment. He joined Vickers in 1938.

JOHN T. BURNS has been appointed manager—western region for aircraft products sales for Vickers Inc. in Detroit. His new office will be at the El Segundo, Calif. Division of Vickers.

Assisting Burns is a staff of seven application and coordinating engineers. This group will be responsible for providing design, development, and application engineering assistance to users of airborne oil-hydraulic systems in the western United States.

Prior to joining Vickers, he had been Douglas Aircraft Co.'s assistant hydraulic and landing gear section chief.

HOWARD H. ARNOLD JR. has joined the Pan American World Airways, Inc. as a flight engineer. Arnold was a senior production liaison engineer with Lockheed Aircraft Corp., Georgia Division.

WILLIAM L. NAUMANN, manager of the Joliet, Ill., plant of Caterpillar Tractor Co., has been appointed manager of the Peoria plant. He has previously served as factory manager and assistant general factory manager at Peoria.

DONALD P. HESS is now chairman of the board and director of Van Norman Industries, Inc., Springfield, Mass. He had previously been a director of American Bosch Arma Corp.

GM Promotes . . .

Cole

Critchfield

Knudsen

Truxell

Habel

Executive shifts in General Motors Corp. last month involved a number of SAE members.

EDWARD N. COLE, chief engineer of Chevrolet since May, 1952, has been named general manager of Chevrolet, a vice-president of GMC, and a member of GM's Administration Committee. He joined GMC in 1930 as a laboratory assistant in the engineering laboratory. He advanced to chief engineer of Cadillac and, in 1950, became manager of Cadillac's tank production plant at Cleveland, a position he held until his transfer to Chevrolet in 1952. Cole is an SAE past vice-president for Passenger Car Activity, and a past chairman of the SAE Detroit Section. He is currently chairman of the SAE Sections Committee.

ROBERT M. CRITCHFIELD, vice-president of GM and general manager of the Pontiac Motor Division since July, 1952, is to be charge in of the process development staff at the General Motors Technical Center. Critchfield joined GM in 1921 and served as assistant general manager of the Allison Division prior to appointment as general manager of Pontiac.

His appointment marks the first time in GM history that a vice-president has headed process development. Prior to this change, the position had been held by an engineering executive operating under the manufacturing staff. Critchfield, however, will report directly to **HARLOW H. CURTICE**, GM president.

Critchfield has also been awarded one of Ohio State's University's top honors —the Benjamin G. Lamme Medal.

SEMON E. KNUDSEN, general manager of the Detroit Diesel Engine Division since March, 1955, succeeds Critchfield as general manager of Pontiac and has also been appointed a vice-president of GMC and a member of the Administration Committee. Knudsen, son of the late William S. Knudsen, formerly president of General Motors, began his career with the Pontiac Division in January, 1939, on a special manufacturing assignment. He served successively as chief inspector—defense plant, superintendent of the car assembly plant, and assistant general master mechanic at Pontiac. He subsequently served as director of GM's Central Office process development section and as assistant manufacturing manager of aircraft engine operations at the Allison Division.

CLYDE W. TRUXELL, JR., works manager of the Detroit Diesel Engine Division, succeeds Knudsen as general manager of the division. Truxell joined GM in 1932 as a designer of the GM research staff.

O. WILLIAM HABEL, general works manager of the Saginaw Steering Gear Division since 1942, has become general manager of the Detroit Transmission Division. He has been associated with GM since 1923 when he joined the Delco-Remy Division at Anderson, Ind., as a student engineer.

D. R. KINKER has been promoted from resident engineer—Mound Rd. Engine Plant of the Chrysler Corp. to divisional chief engineer in the Engine Division.

Kinker has been actively engaged in the Detroit Junior Group of SAE. He served as a member of the Reception and Program Committees and chairman of the Henry Ford Memorial Award Committee in past years, and is currently serving as chairman of the Publicity Committee, Junior Group, and associate editor of the Supercharger.

R. C. BECKETT has been named chief engineer for Commercial Filters Corp. Commercial Filters recently acquired the Michiana Products Corp. of which Beckett had been chief engineer in the Filter Division.

HENRY J. JOHNSON, JR. has been named research analyst "A" in the fluids systems section of the Power Plant Engineering Department of Northrop Aircraft, Inc.

Johnson was test engineer at Hamilton Standard Division of United Aircraft Corp.

NIELS C. BECK, of Armour Research Foundation of Illinois Institute of Technology, Chicago, has been named new director-general of the Union of Burma Applied Research Institute at Rangoon.

Beck joined ARF in 1953 as program development engineer and was promoted to assistant manager of program development in 1955.

ROBERT W. POWELL, Chicago regional manager of the Fafnir Bearing Co. of New Britain, Conn., has been named general sales manager of Fafnir. Previously he was head of Fafnir's Chicago sales territory in 1936. **CHAUNCEY W. OLSON**, Moline district manager, will succeed Powell. With Fafnir since 1935, Olson was also district manager of both the Denver and Minneapolis offices.

DANIEL N. McNALLY has joined the Sikorsky Aircraft Division of United Aircraft Corp. as a design analysis engineer in the Development Engineering Department. McNally had been an experimental engineer with the Lycoming Division of Avco Mfg. Corp. in Stratford, Conn.

W. R. RHOADS, chief staff engineer of Lockheed Aircraft's Georgia Division, has been appointed director of the Georgia Nuclear Aircraft Test Laboratories. The laboratories will be operated for the U. S. Air Force by Lockheed near Dawsonville, Ga.

Rhoads will direct the work of some 500 scientists, engineers, technicians, and service personnel who will conduct a research and testing program when the laboratories and research reactors are ready for operation.

ROY T. HURLEY and **EDWARD RICKENBACKER** were among the recipients of the tenth annual Horatio Alger Awards, given to the men whose lives bear out the philosophy of the nineteenth century writer who extolled the simple virtues of thrift and diligence as the surest paths to success.

Hurley is president of Curtiss-Wright Corp. Rickenbacker is president of Eastern Air Lines.

H. W. ROYL, a past-chairman of SAE Montreal Section, has been appointed sales manager of Curtiss-Wright of Canada, Ltd. He has been works manager of Sperry Gyroscope Co. of Canada, Ltd., Division of Sperry Rand Corp.

Montreal Section 1955–1956 secretary **D. J. MUNRO** is now general supervisor with the Montreal Transportation Committee. He had been superintendent of maintenance for the Autobus Department.

FOREST McFARLAND is now with Buick Motor Division, GMC, as assistant chief engineer. He has been chief engineer, Advanced Engineering, Studebaker-Packard Corp.

McFarland is a member of SAE Passenger Car Activity Committee.

HARRY WOODHEAD, formerly vice-president and general manager of the Tulsa Division of the Douglas Aircraft Co., Inc., has been appointed consultant to the president's staff at Western Pressed Metals Division of Douglas.

GEORGE E. TUBB has been named marketing manager of Small Aircraft Engine Department, General Electric Co., West Lynn, Mass.

Previously, Tubb was vice-president of sales with the Lord Manufacturing Co. in Erie, Pa.

F. P. HALL, JR., who was manager of the Axle Division at the Dana Corp. in Toledo, Ohio, has retired.

ERLE MARTIN, general manager of Hamilton Standard Division of United Aircraft Corp., received a gold watch recognizing 25 years of service with the company. He was awarded his watch by **H. M. HORNER**, president of United.

Martin joined Hamilton in 1931, and was named general manager in 1946. He was elected a vice-president of United Aircraft in 1952 and a member of United's operating and policy committee last year.

WILL W. WHITE, a veteran of more than 25 years in the aviation fuel and lubricants field, has been elected a vice-president of Esso Research and Engineering Co., in New York City.

White will serve in a consulting and advisory capacity, analyzing developments affecting petroleum products used in aircraft. White joined what is now Esso Standard Oil Co. in 1930.

SAE Father and Son

CHARLES O. GUERNSEY (left), vice-president and manager of the Transit Equipment Division, Marmon-Herrington Co., Inc., is an SAE Father. His son, **GLEN A. GUERNSEY** (right), is manager of engineering with Wico Electric Co., Division of Globe-Union, Inc.

The senior Guernsey was chairman of Philadelphia Section in 1925–1926, second vice-president representing Stationary Internal Combustion Engineering in 1926, and vice-president representing Truck, Bus, & Railcar Engineering in 1936. He will resign as manager of the Transit Equipment Division on Sept. 1, but will remain as a vice-president and director of Marmon-Herrington.

VIRGIL EXNER (left), director of styling of Chrysler Corp., presents a $10,000 check in behalf of Chrysler Corp. to Rev. Theodore Hesburgh, C.S.C., president of the University of Notre Dame. The Chrysler grant will support a course in "Automotive Design" in the Notre Dame art department. Exner is a member of the University's Advisory Council for the Liberal and Fine Arts.

News From Chevrolet

Barr

HARRY F. BARR has been appointed chief engineer of the Chevrolet Motor Division, GMC, **E. N. COLE**, new general manager of the Division, has announced. Barr joined Cadillac as a laboratory technician in 1929. He worked with Cole at Cadillac, directing the development of the short-stroke V-8 engine introduced by Cadillac in 1949. In 1952 at Chevrolet, working under Cole, Barr led the development of the V-8 Engine introduced by Chevrolet two years ago. He has been assistant chief engineer in charge of passenger car chassis and experimental test operations.

The Barr appointment heads a list of promotions in the Chevrolet engineering Department, following the elevation of Cole from chief engineer to general manager of the Division.

Assistant Chief Engineers

Premo

Sanders

Schroeder

Rosenberger

E. J. PREMO has been appointed executive assistant chief engineer. He joined Chevrolet in 1935 as a detailer. He worked up through the design departments and was appointed an assistant chief engineer in charge of car and truck body design in 1952.

R. F. SANDERS has been named assistant chief engineer in charge of passenger car chassis design. He has been a staff engineer. He joined Chevrolet as a special test engineer at the Proving Ground in 1934.

H. H. SCHROEDER is now assistant chief engineer in charge of passenger car and truck body design. He joined the Division in 1939 as a designer and held design posts of progressive responsibility until he was appointed staff engineer in charge of passenger car body design in 1952.

M. S. ROSENBERGER, chief experimental engineer, has been appointed assistant chief engineer in charge of experimental test operations. He started with the Cadillac Motor Division in 1927. He was associated with early automatic transmission development both at Cadillac and on the General Motors Staff. He was named chief experimental engineer at Chevrolet in 1953.

Staff Engineers

Aitken

Dougherty

Farley

MacKenzie

McCuen

Rausch

Roensch

Barr announced the appointment of the following SAE members to the position of staff engineer.

G. C. AITKEN is appointed staff engineer in charge of drafting, records and specifications, and office services.

T. E. DOUGHERTY is appointed staff engineer in his capacity as director of experimental fabrication and vehicle building.

N. E. FARLEY is appointed staff engineer in his capacity as director of Chevrolet Proving Ground operations.

W. R. MACKENZIE is appointed staff engineer in his capacity as director of product information and public relations.

N. H. McCUEN is appointed staff engineer in charge of passenger car chassis and transmission design.

J. T. RAUSCH is appointed staff engineer in charge of engine design.

M. M. ROENSCH is appointed staff engineer in his capacity as director of laboratories, motor, axle, and transmission rooms.

Other changes affecting SAE members are as follows:

D. W. BAIN assumes the duties of director of drafting.

J. B. BURNELL becomes assistant staff engineer in charge of passenger car engine design.

E. B. ETCHELLS becomes assistant staff engineer in charge of truck engine design.

D. R. REMY is in charge of passenger car body design.

F. J. WINCHELL is now assistant staff engineer in charge of passenger car transmission design.

ERWIN A. WEISS has retired as executive engineer of the Packard Division of Studebaker-Packard Corp. He has been with the company since 1934. Prior to that, he was chief engineer of the Excelsior Motorcycle Co., assistant chief engineer of Mitchell Motors, and chief engineer of Willys-Overland. Weiss joined Packard as chassis engineer to design the Model 120. He has been a member of SAE since 1917.

GEORGE J. TOTH, who was vice-president of Atlantic Equipment Co., Inc., is now district manager of New England and the Maritime Provinces for the Pettibone Mulliken Corp. in Chicago.

BRUCE W. WADMAN is the new managing editor of *Diesel Progress*, the trade publication of Diesel Engines, Inc. Before being appointed managing editor, Wadman served as midwest editor.

EDGARD C. DeSMET plans to move to Detroit next fall to undertake some engineering projects in a consulting capacity in the field of body engineering. He will continue to teach his private course in body surface design and planography which he has carried on continuously since 1922. DeSmet resigned late in May as executive engineer, Willys Motors, Inc., Toledo, following 20 years of service with that organization. He is an SAE past vice-president representing Body Engineering.

EDWIN E. BRYANT has been named president of Nelson Muffler Corp. to succeed the late **C. E. NELSON.** (See obituary notice on page 93) Bryant has been serving as vice-president and treasurer of the corporation.

GEORGE T. BYNUM, previously a chief engineer at Aircooled Motors, Inc., is now chief of the engine controls section in the Aeronautical Division of the Minneapolis-Honeywell Regulator Co.

JOHN STIRLING has been promoted from supervisor, training section, Cleveland Plant of the Ford Motor Co., to manager of the Industrial Relations Department at the Lima engine plant in Lima, Ohio.

ALAN CARL SKINROOD, formerly a graduate student and research assistant at Northwestern University, is now a staff member of the Sandia Corp., Sandia Base, Albuquerque, N. M.

W. J. PURCHAS, JR. has been appointed chief engineer for the Bearings Department of Transmissions Operations of the Allison Division of General Motors Corp.

Purchas joins Allison with 17 years' service in the GM organization.

KARL B. RAHAM, former manager of Raham's Esso Service Station in Ontario, Can., is now a dynamometer engineer with Reo Motors, Inc., Lansing, Mich.

C. L. JOHNSON, vice-president for research and development, Lockheed Aircraft Corp., has been named "Aviation Man of the Year" by a panel of Southern California aviation writers and editors.

He received a plaque symbolizing the honor at the annual Airline Ball held in Santa Monica in late May. The honor was in recognition of his role in developing the supersonic F-104 Starfighter and the new turboprop Electra.

RICHARD H. BANCROFT, an executive of Perfect Circle Corp., will be ordained a deacon of the Episcopal Church.

Bancroft is manager of Perfect Circle's castings division and is president of Centrifugal Foundry Co. of Muskegon, Mich., a Perfect Circle subsidiary.

WRIGHT A. PARKINS, engineering manager of Pratt & Whitney Aircraft Division, United Aircraft Corp., was elected general manager of the division, a vice-president of the corporation, and a member of the operating and policy committee.

ARTHUR E. SMITH, assistant engineering manager, was appointed engineering manager of Pratt & Whitney to succeed Parkins.

WILLIAM K. PARK is now account manager with E. I. du Pont de Nemours & Co., Inc. Park had been sales-service representative with du Pont.

WILLIAM P. LEAR (left), chairman of the board, Lear, Inc., has been flying a Cessna 310 about Europe to demonstrate to all the countries the great efficiency and utility of a company-operated airplane. He landed in Moscow on one of these trips during the visit to Russia of Gen. Nathan F. Twining. (Lear's son (right) delivered the company plane to his father in Geneva, Switzerland, about five months ago.) Lear has established permanent residence in Geneva, following establishment by Lear, Inc., of two European divisions, one in Geneva and the other in Munich, Germany. Lear also has divisions at Santa Monica, Calif., Grand Rapids, Mich., and Elyria, Ohio with corporate headquarters in Santa Monica.

McKinley Matousek Jackson Galliger

WILLIAM A. McKINLEY, president of Midland Steel Products Co. since 1952, has been elected chairman of the board of the company.

McKinley started with Midland's predecessor, Detroit Pressed Steel Co., in 1919 as a draftsman.

When Detroit Pressed merged with Parish & Bingham Co. and the Parish Mfg. Co. to form Midland Steel in 1923, McKinley became vice-president in charge of engineering. Prior to being elected president, he served as executive vice-president.

JOHN A. MATOUSEK has been appointed assistant to the president of the Baker-Raulang Co. In his new capacity he will aid on general staff problems and handle special assignments in fleet sales, new market and product programs, and industrial relations.

Matousek joined Baker-Raulang in 1950 as plant manager. Previously, he was division manager in Detroit for the Hupp Motor Corp.

IVAN W. HANSEN is now a sales engineer with Hyatt Bearing Division of General Motors Corp., Detroit. His previous position was sales engineer with Delco Appliance Division of GM.

RICHARD H. GARDNER has changed position from Cleveland Diesel Engine Division of General Motors Corp. to Pratt & Whitney Aircraft Division of United Aircraft Corp. He will be senior test engineer with the company.

RICHARD J. CRANE, formerly in contract administration and government liaison with the Ford Motor Co., is now contract administrator with Temco Aircraft Corp., in Dallas, Texas.

WILLIAM C. EAVES is now vice-president and general manager of Contour Truck Guards, Inc. in Chicago. His previous position was automotive and electrical engineer with Flexi-Fend Corp., an affiliate of Gar Wood Industries of Cleveland.

SAMUEL L. HIGGINBOTTOM has been named director of engineering at Trans World Airlines, Inc. in Kansas City, Kansas. He was manager of airframe engineering with TWA.

Higginbottom was the 1954–1955 SAE Kansas City Section vice-chairman of aeronautics.

JOHN A. JACKSON has been appointed sales manager—plastics of Stokes Molded Products, Division of Electric Storage Battery Co. in Trenton. Jackson formerly was assistant sales manager of plastics at Stokes.

KARL W. GALLIGER has been appointed director of engineering of the New York Air Brake Co. In his new capacity Galliger will be responsible for company research and engineering, and for organization policies, procedures, and development programs of the engineering departments of all divisions of the company. He will be located in New York and will report directly to the company president.

Galliger first became associated with the company in Chicago in 1941, but soon left to join the U. S. Army Corps of Engineers where he attained the rank of Lieutenant Colonel. Returning to New York Air Brake in 1945, he was assigned to design engineering in hydraulics at Watertown.

He became director of hydraulic engineering in 1952, director of the aircraft technical sales section in March, 1953, and engineering manager of the Watertown Division in December, 1953.

F. L. LaQUE, vice-president of the International Nickel Co., Inc., and manager of its Development and Research Division, will discuss the planning and interpretation of corrosion tests in a talk before a joint meeting of the Baltimore and Washington Sections of the National Association of Corrosion Engineers, American Electroplaters' Society, and the Electrochemical Society.

M. K. MEHTA has left Capsulation Services Ltd., Bombay to join the Ministry of Iron & Steel, Bhilai Project, Government of India, as a mechanical design engineer.

WILLIAM R. SHIMMIN is now a senior engineer with Crown Zellerbach Corp. of Camas, Wash. Prior to joining Crown Zellerbach, Shimmin was group leader in the Research Department of Standard Oil Co., Indiana Division.

RUSH SIMONSON, formerly southern zone manager with Automotive Products Sales, National Accounts, National Carbon Co. in New York, is now southwestern Division manager with offices in Dallas, Texas.

JAMES J. CROOKSTON, formerly a project engineer with Ward LaFrance Truck Corp., Elmira, N. Y., is now a project engineer with the Research Division of Yale & Towne Manufacturing Co., Valley Forge, Pa.

WILLIAM J. BURKE has been named assistant division manager of the Texas Co. of Minneapolis. In his new position, Burke will act as industrial sales manager for the Minneapolis Division of the company. He had been a supervising engineer.

MILTON D. BEHRENS, previously senior project engineer in the Automotive Engineering Laboratory Division at Aberdeen Proving Ground, is now a research engineer on the engineering staff of the Ford Motor Co. in Dearborn, Mich.

J. CHRIS GREEN is a mechanical engineer with Collins Radio Co., Cedar Rapids, Iowa. Green's previous position was district service engineer with the New York Air Brake Co.

W. M. LETTERIS, formerly chief inspector at the American Bosch Arma Corp., in Springfield, Mass., has been named assistant manager, Product Quality Division of American Bosch Arma.

FOSTER N. PERRY has joined the Robert Bosch Co. of Germany. Perry resigned from American Bosch a few month's ago after 32 years' service. He was executive vice-president.

JOHN E. BRENNAN, general manager of Chrysler Corp.'s Automotive Body Division, has been elected a vice-president of the corporation.

R. S. BRIGHT, group executive in charge of the engine and transmission group, has also been elected a vice-president of Chrysler.

DR. E. A. WATSON, director and chief engineer, Joseph Lucas, Ltd., Birmingham, England has won the James Clayton Award for his paper entitled, "Fuel Control and Burning in Aero-Gas-Turbine Engines." The paper was presented before the Institution of Mechanical Engineers in England on Dec. 16, 1955.

ROY I. ANDERSON is now a production engineer with General Electric Co. He was production supervisor with E. I. du Pont de Nemours & Co., Inc.

LADDIE J. PESEK, who was a field engineer in the Chicago territory for the Cleveland Graphite Bronze Co., has been named senior product design engineer for Cleveland Graphite.

CHARLES B. SMALL, former product design and development engineer, has been made field engineer for the Chicago territory.

CONTINUED ON PAGE 94

Obituaries

BERTRAM H. SALTZER

Bertram H. Saltzer, active in professional engineering and musical circles, died April 20. He was engineering recruiting & training administrator, Wright Aeronautical Division, Curtiss-Wright Corp.

He was graduated from the Pennsylvania State College in 1923 with a BS in Mechanical Engineering. In 1928 he received his MS from the same school.

After graduation from college, he worked as an engineer in the Steelton Plant of the Bethlehem Steel Corp. For 17 years he was instructor and assistant professor in mechanical engineering at Gettysburg College. While there he directed the college band and symphony orchestra.

In 1940 he was a designer of tunnel blowers and ventilators for the Pennsylvania Turnpike Commission before joining the Wright Aeronautical Division of Curtiss-Wright Corp. in July. At Wright Aeronautical he was associated with the Engineering Department as training supervisor, director of engineering college recruitment, and administrator of personnel services, placement, and counseling.

Saltzer was a Professional Engineer in Pennsylvania and a member of ASME and the Society for Promotion of Engineering Education.

Active in Ridgewood, Pa. community musical affairs, he was a founder and the first president of the Ridgwood Symphony Orchestra.

WILLIAM L. HUDSON

William L. Hudson, assistant chief engineer, Tokheim Oil Tank & Pump Co., Wayne, Ind., died May 15. He had been with the company since 1943.

Hudson received his BS in Civil Engineering from the University of Illinois in 1932. He had previously been an engineering student at Crane Junior College.

He joined Wm. Meyer Co. of Chicago as assistant chief engineer immediately after graduating in 1932. In 1936 he became owner and president of Hudson-Designs, Chicago.

In 1941, he moved to the Fort Wayne Ordnance Office of Chicago Ordnance District as industrial chief. He held this position until 1943, when he joined Tokheim Oil Tank & Pump Co.

JAMES LYNAH

James Lynah, retired from industry since 1943, died Feb. 24. He was 75.

Lynah had been a member of SAE since 1922. He was also a member of A.S.M.E., an Associate Member of the American Institute of Electrical Engineers, and a member of the American Society for the Advancement of Science, and the American Academy of Political & Social Sciences. He received his ME in Mechanical Engineering from Cornell University in 1905.

He spent his first 15 years after graduating from Cornell with E. I. du Pont de Nemours & Co., Inc. He started as an electrical engineer in the Black Powder Operations Department and by 1920 was a special assistant engaged in special operating studies.

In 1922, Lynah joined General Motors Corp. as an assistant director of the purchasing section. He was with the corporation until 1931, when he served as director of staff, works managers, and general purchasing committees.

He left industry in 1936 to become director of physical education and athletics at Cornell University, his alma mater.

CHARLES EMORY NELSON

Charles Emory Nelson, president and general manager of the Nelson Muffler Corp., which has its general offices at Stoughton, Wis., was killed in an automobile accident at Madison, Wis., Wednesday, May 23, 1956.

Nelson was born May 15, 1903 at LaPorte, Ind. He attended the LaPorte grade and high schools. He also attended the City College of Detroit, and received his BS Degree in Electrical Engineering from the University of Michigan in 1929.

After graduation he was with the Michigan Bell Telephone Co., where he held an important position associated with the installation of the first dial system in Detroit. Nelson joined the C. F. Burgess Laboratories after leaving the Bell Telephone Co., and managed the Detroit district office from 1930 to 1935, at which time he was associated with the acoustical research projects conducted at the University of Michigan. Nelson was chief engineer of the Acoustical Division of the Burgess Battery Co. from 1935 to 1939.

In 1939, along with E. E. Bryant and O. F. Gusloff, he organized and became president and general manager of the Nelson Muffler Corp. The corporation operates three plants located in Black River Falls, Niellsville, and Mineral Point—all in Wisconsin.

Nelson was active in SAE and the Acoustical Society of America. He has presented technical papers, and has participated in technical committee work in both of these organizations. He was a Mason, a member of the Stoughton Rotary Club, and also a past-president of the Stoughton School Board.

WILLIAM E. IRELAND

William E. Ireland, vice-president, Sales, B. F. Goodrich Rubber Co. of Canada, Ltd., Kitchener, Ontario, died May 21.

Ireland had been with B. F. Goodrich Rubber Co. since 1934. He started at the Akron, Ohio plant on field sales assignments. By 1954 he was sales manager of that plant. He became vice-president in charge of sales in 1947. In 1950 he moved to the Kitchener, Ontario branch as vice-president in charge of tire sales. He was vice-president, Sales, until the time of his death.

R. ELMER MINTON

R. Elmer Minton, management controls administrator for Republic Aviation Corp., died April 27 of leukemia. He had been in the aviation field since 1929.

After graduating from Purdue University with a BS in Mechanical Engineering, he joined Curtiss Airplane Division, Curtiss-Wright Corp., as an engineer. He became manager of the Installations and Service Department in 1937 and then sales manager in 1941.

In 1951, Minton went to Republic Aviation as facilities coordinator. Two years later he was named management controls administrator.

He was a member of Conquistadores del Cielo.

JUDD H. LINDAUER

Judd H. Lindauer, general manager of Lindauer & Lindauer Co., Watsontown, Pa., died Jan. 17. He had just joined SAE in 1955.

Lindauer started in industry in 1923 as assistant service manager with Lycoming Mfg. Co., Williamsport, Pa. He entered the garage business in Williamsport 10 years later. In 1934 he joined the Pennsylvania Department of Highways, District #2 as equipment engineer in charge of all highway equipment in eight counties of District #2.

He moved to Cleveland in 1939, where he served as assistant service manager for Cleveland Tractor Co. and later became a district manager.

From 1951 to 1953 he served as principal industrial specialist with the National Production Authority of the U. S. Government. In this position, he handled trade with Canada in connection with construction, electrical, industrial, and communications machinery. He then served for a year as industrial sales manager for Oliver Corp., Richmond, Va. before organizing Lindauer & Lindauer Co. in Watsontown, Pa.

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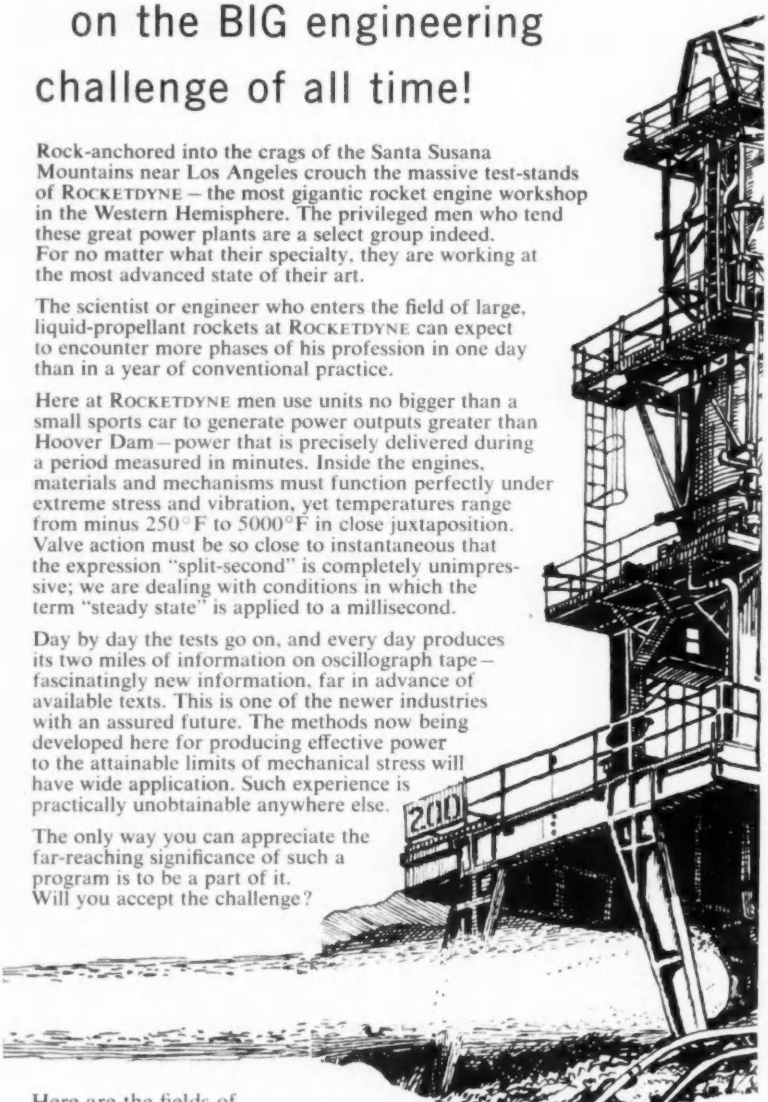

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About SAE Members

Continued from page 92

DONALD L. BOWER, formerly with the U. S. Plywood Corp., Chicago has been appointed planning specialist at the White House Public Works Planning Unit in Washington, D. C.

WILLIAM E. NEWTON has been named assistant manager, service and parts, east coast district of the Cleveland Diesel Engine Division of General Motors Corp. He had been a service engineer with Cleveland Diesel prior to his new appointment.

ROLAND R. CLARK has joined Associated Missile Products Corp. of Pomona, Calif. as a mechanical engineer.

ROBERT C. WATTLEWORTH, formerly a design draftsman with the Flxible Co. of Loudonville, Ohio, is now senior designer at the Four Wheel Drive Auto Co. in Clintonville, Wis.

WALTER J. STEIN has been made an associate design engineer with Lockheed Aircraft Corp. of Burbank, Calif.

EDWARD T. RAGSDALE, general manager of the Buick Motor Division, has been elected a vice-president of General Motors and a member of the administration committee.

ALBERT A. KAUSLICK, formerly with the Air Research and Development Command in the Department of the Air Force, has joined the Columbia-Southern Chemical Corp., Barberton, Ohio.

RICHARD C. KORFF is now an industrial engineer with P. R. Mallory Co., Indianapolis. He had been with Hotpoint, Inc. as an industrial engineer.

KENNETH D. LEWIS has been named manager of design in the Centrifugal Division of Dorr Oliver, Inc. of Oakland, Calif. Lewis had been chief engineer with the Merco Centrifugal Co., which was acquired by Dorr earlier this year.

GORDON W. DUNCAN has been named assistant manager of the office of scientific liaison, Esso Research and Engineering Co., New York, N.Y. Duncan, who has served as an assistant director of the products research division since 1953, joined Esso Research in 1937.

CHARLES C. KOSTAN is a project engineer in the Electrical Engineering Department of Ford Motor Co. Kostan had been an engineer with the Electric Auto-Lite Co. of Toledo.

CONTINUED ON PAGE 95

JACK KERNS, previously assistant branch manager at Detroit of Raybestos-Manhattan, Inc., Manheim, Pa., has been appointed Detroit branch manager.

LESLIE JOHN LaDOUCEUR has been named chief engineer with William Christensen & Co. LaDouceur had been electrical labortory head with the American Motors Corp.

R. DIXON SPEAS' book "Technical Aspects of Air Transport Management" has recently been issued by McGraw-Hill Book Co., Inc. at $8.50. According to the book jacket, the volume was written for airline employees and others who want a reference on airline operating procedures and management policies. The 16 chapters cover such subjects as fuel-load requirements, weight and balance problems, communications and meteorology, and cargo operations.

In the preface, Speas pays tribute to **William Littlewood, Otto Kirchner,** and **Dan Beard** for years of practical lessons in the technical aspects of air-transportation management.

WILLIAM F. NUNNOLD has been made supervisory contact engineer in the Mound Rd. Engine Division of Chrysler Corp. in Detroit. Nunnold had been a test and development engineer in the Central Engineering Division of Chrysler.

CLYDE PARTON has been named manager of the Ordnance Division of Minneapolis-Honeywell Regulator Co. Previously, he had been director of engineering for the Aeronautical Division of Honeywell.

RALPH F. PEO, president of Houdaille Industries, Inc., has been elected chairman of the board and will serve in both capacities. Peo, as chairman, succeeds **CHARLES GETLER**, who is retiring. Getler was associated with one of the original companies that formed Houdaille-Hershey Corp.

FRANK N. PIASECKI, president of Piasecki Aircraft Corp., received a special citation from the City Council of Philadelphia for his leadership in organizing the first Free Polish Merchant Marine.

P. J. REESE has been advanced to assistant director of research and development of Wagner Electric Corp., St. Louis. Reese has been employed by the Wagner Corp. since 1929 and prior to his present assignment was manager of development and application engineering, Automotive Division.

E. E. WALLACE, formerly supervisor of hydraulic brake development and field brake applications at Wagner, has been appointed chief product engineer, automotive and industrial brake products.

W. R. FREEMAN, who was chief automotive engineer, has been made consulting engineer on automotive product design, research, and development.

JAMES P. FALVEY, president of the Electric Auto-Lite Co., Toledo, Ohio, has announced the establishment of a new company to manufacture electric storage batteries in Caracas, Venezuela. The new firm, Corporacion Venezolana De Acumuladores, S.A., involves the Electric Auto-Lite Co. and Venezuelan interests. Batteries for cars, trucks, and tractors will be produced at the Caracas plant for the Venezuelan market, and distribution will be continued through organizations now handling Auto-Lite and Prest-O-Lite Batteries imported from the United States.

JOSEPH GESCHELIN, Detroit editor of Chilton Publications, addressed a meeting of the Naval Reserve Material Co. at the Bodhead Naval Armory in

CONTINUED ON PAGE 96

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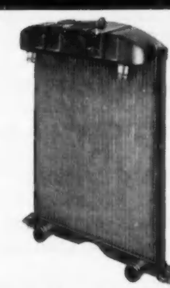

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SEAL RINGS
FRICTION SEGMENTS
TROLLEY SHOES
CHEMICAL CARBON and GRAPHITE ANODES (Plain or treated)
CARBON RODS FOR SALT BATH RECTIFICATION
CLUTCH RINGS
ELECTRIC FURNACE HEATING ELEMENTS
BRAZING FURNACE BOATS and FIXTURES
CONTINUOUS CASTING DIES
PUMP VANES
PURE CARBON . . . and many other carbon-graphite-metal powder products

STACKPOLE
WRITE FOR DETAILS ON ANY PRODUCT

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

About SAE Members

Continued from page 95

Detroit July 10. The subject of his presentation was a general coverage of new materials, new manufacturing techniques, and emphasis upon automation and its effects upon the production process.

LEWIS A. WINKLER has been named a section head in the technical service unit of the Esso Research and Engineering Co., New York, N.Y. In his post, Winkler is responsible for certain of the firm's work on additives. Previously he had been a group head.

With the company since 1947, Winkler started in the asphalt group in the firm's process research division. He transferred to the products research division in 1950, and was named a group head to work on heavy duty oil projects in 1952. He's been with the technical service unit two years.

HERBERT EARL JOHNSON III has been appointed assistant professor of mechanical engineering in the Mechanical Engineering Department at the University of Colorado. His previous position was assistant professor of mechanical engineering at the University of Wyoming. Johnson will assume his new duties in September.

ARTHUR C. BUTLER, director of the National Highway Users Conference, Washington, D. C., has been chosen to receive the Los Angeles Automotive Council's Annual Tribute Award for having made the greatest contribution during the past year to the trucking and transportation industries.

WILLIAM MILNE, western advertising manager, Chicago, *SAE Journal,* was elected vice-president of the Wilmette Little League at a recent meeting of the Wilmette Baseball Association.

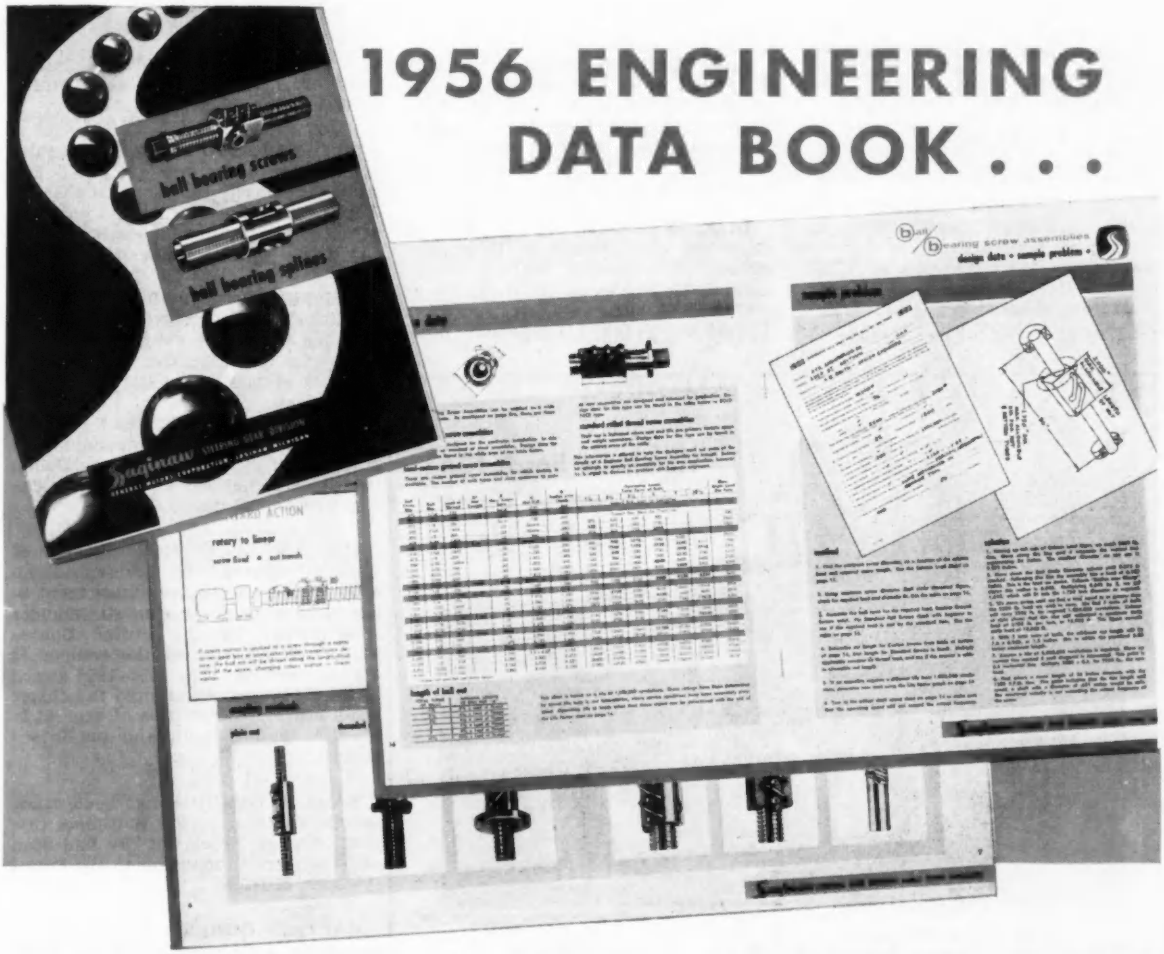
HARVEY B. WILGUS has been appointed general sales manager for Electric Products Co. in Cleveland. In his new position, Wilgus will be responsible for the sales activities in all divisions of the company. Before joining Electric Products, he had been general sales manager of Redmond Co., Inc., Owosso, Mich.

RUDOLPH H. COOK has joined Lockheed Aircraft Corp. in Burbank, Calif. as an instrumentation engineer. Cook had been a development engineer with Western Electric Co.

WILLIAM A. CZAPAR, previously a military project engineer in the Automotive Division Department at Aberdeen Proving Ground in Maryland, is now doing graduate work in business administration at the National University of Mexico.

CONTINUED ON PAGE 98

1956 ENGINEERING DATA BOOK . . .



SHOWS HOW SAGINAW b/b SCREWS and SPLINES FREE YOU FROM DESIGN LIMITATIONS OF ORDINARY ACTUATORS and POSITIONERS

BOOK CONTENTS: Principle • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Charts: Expected Life, Critical Speed, Column Load • Design Data • Sample Problem • Typical Custom Assemblies • Standard Assemblies

SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require 2/3 LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +400° F. Two types: precision-ground or economical rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 9 ft. long.

Saginaw
ball bearing
Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND COUPON FOR 32-PAGE ENGINEERING DATA BOOK

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 6E, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME ____________________

COMPANY ____________ TITLE ____________

ADDRESS ____________________

CITY ____________ ZONE ______ STATE ______

About SAE Members

Continued from page 96

W. C. NEWBERG, president of the Dodge Division of Chrysler Corp., has received an honorary degree from his alma mater, the University of Washington. He was also voted by the alumni as the outstanding alumnus of the year.

J. A. KEENETH, owner of the J. A. Keeneth Co., a sales and product application service in Long Island, N. Y., has announced the company's appointment as eastern district representative for Allen Aircraft Products, Inc., of Ravenna, Ohio.

W. E. SPARROW has resigned the managing directorships of three subsidiary companies of Birfield Industries, Ltd.—Hardy Spicer, Ltd., Forgings & Presswork, Ltd., and Salisbury Transmission, Ltd. His present position and title is now Birfield Industries' chief executive of development in Warwickshire, England.

RICHARD J. NUFFER is now sales engineer with the Anderson Co., Detroit. Previously he was with Electric Auto-Lite Co. He will be concerned with original equipment application of windshield wiper equipment.

HERBERT R. FORTGANG and **FORREST K. POLING** have been awarded Sloan Fellowships for participation in the executive development program at Massachusetts Institute of Technology.

Fortgang is assistant chief engineer in the Product Study Components Department of the Ford Motor Co. Poling is a project engineer for Ford Suspension at Ford Motor Co.

HARLOW H. CURTICE, president of General Motors, was presented an award for "meritorious achievement in the field of management-shareholder relationship" by the United Shareholders of America at the company's annual meeting. The 1955–1956 award to the GM chief represented the choice of an advisory committee of experts in finance, management, and public relations.

EARL E. BISCHOF has been made service manager of the Baltimore district of Mack Truck Co. He had been assistant service manager in the Pennsylvania district.

CAPTAIN ROBERT J. HEFFERON has been transferred from the Ordnance Corps, U. S. Army at Aberdeen Proving Ground in Maryland to the Ordnance Corps, U. S. Army at Tandia Base, Albuquerque, New Mexico.

C. HOPPE, JR., who was manager of the engineering laboratory with Parker Aircraft in Los Angeles, is now a staff assistant to the director of weapon system program in Guided Missiles Research and Development Division of Ramo-Wooldridge Corp. in Los Angeles.

ANDREW J. GREGA is a test engineer with Convair Division of General Dynamics Corp., San Diego. Before joining Convair, he was a product engineer with Cleveland Graphite Bronze Co.

OLIVER E. SPENCER is now a Second Lieutenant with the U. S. Air Force at Bolling Field, Washington, D. C. Spencer was a sales trainee with Leeds & Northrup Co. in Philadelphia.

EDWIN A. SPEAKMAN was one of eight representatives of the United States aircraft industry sent to Munich, Germany, to attend a Guided Missiles

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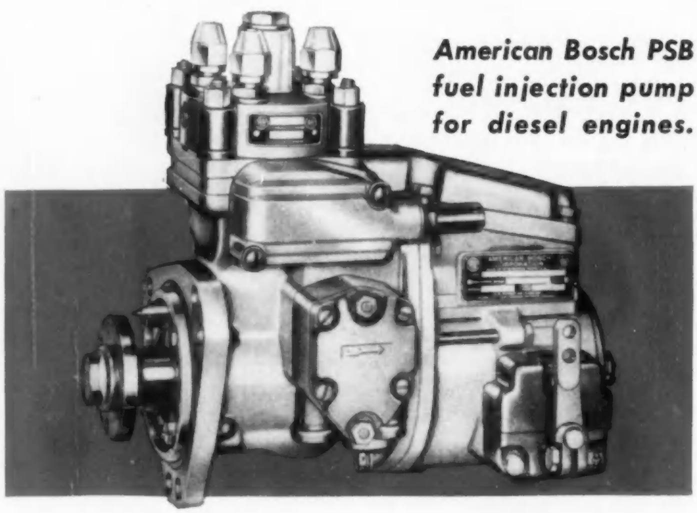

American Bosch PSB fuel injection pump for diesel engines.

Unmatched for service and performance . . .

That's the record of more than 100,000 American Bosch PSB fuel injection pumps now in service—some for as long as five years. The PSB has many features—simple rugged construction, fewer parts, accurate fuel metering and distribution, positive governor control. Easily replaceable hydraulic head permits quick field servicing. All combine to assure top engine performance and economy of operation, long trouble-free life and *low* maintenance expense.

Every American Bosch fuel injection product is backed by an established and growing system of authorized service agencies, fully equipped and staffed with trained personnel to provide quick, efficient repair service.

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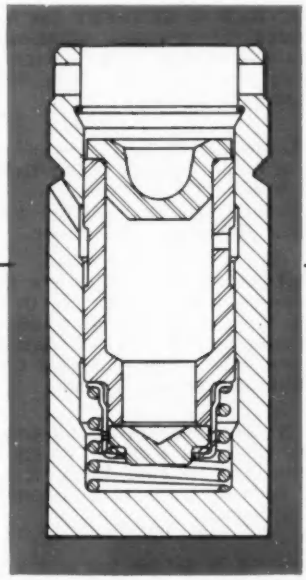
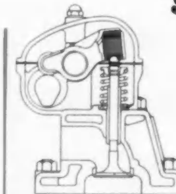
Designing valve gear?

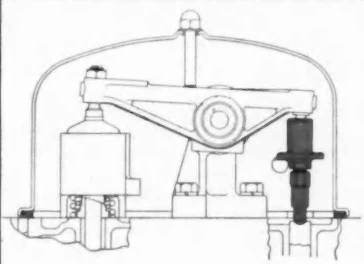
We invite you to use these specialized CHICAGO services



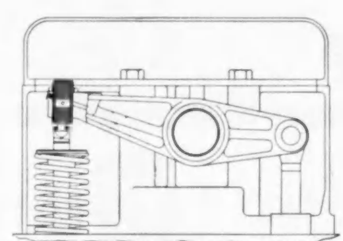
CHICAGO SPRING-LOADED FLAT VALVE HYDRAULIC TAPPET



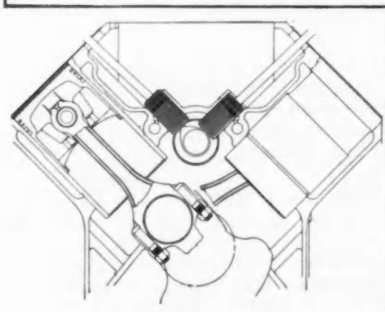
INSERT TYPE ROCKER ARM UNIT



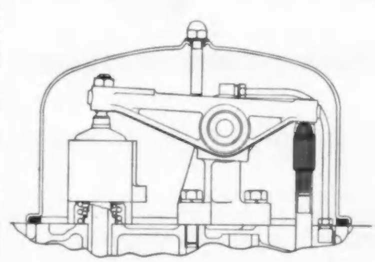
PUSH ROD TYPE FOR COMPRESSION RELEASE APPLICATION



THREADED TYPE ROCKER ARM UNIT



V-8 AUTOMOTIVE HYDRAULIC TAPPET APPLICATION



HYDRAULIC UNIT ON END OF PUSH ROD

Design

of complete valve gear installations for any type of engine . . . passenger car, truck, tractor, diesel, aircraft or industrial.

Development engineering

based on years of specialized experience in valve gear problems. The skills of our engineers will prove a valuable addition to your own engineering staff.

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CHICAGO's facilities insure precision-manufacturing, scientific testing and rugged, trouble-free performance in every tappet. We will welcome the opportunity to serve you.

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THE CHICAGO SCREW COMPANY
Division of Standard Screw Company
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Established 1872

About SAE Members

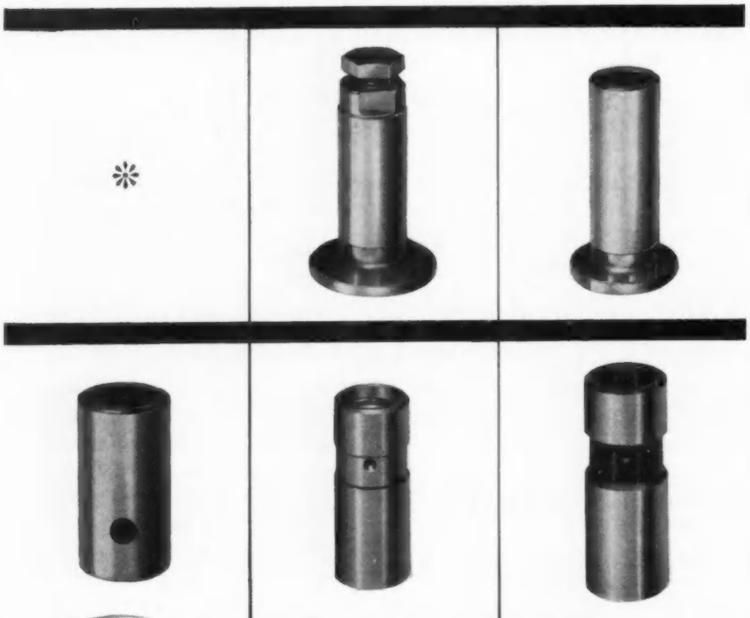
Continued from page 98

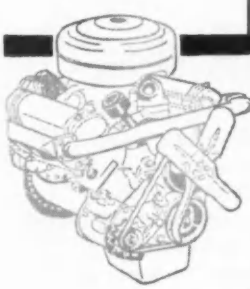
Symposium. Speakman is chairman of the Aircraft Industries Association's Guided Missile committee and vice-president and general manager of the Fairchild Guided Missiles Division of the Fairchild Engine and Airplane Corp., Wyandanch, L. I., N. Y.

WILBUR WEBB, plant manager of the Bendix Aviation Corp., and **H. C. NISSEN**, project engineer at Chance Vought Aircraft, Inc. in Dallas, are two other members of AIA's guided missile committee who visited Munich.

JAY J. MURPHY has been made a field research engineer with the Caterpillar Tractor Co. in East Peoria, Ill. Previously, Murphy had been an engineer at the Caterpillar proving ground in Peoria.

JOHNSON *tappets*





keep pace with today's engines

Continual experimentation and excellent manufacturing methods show a steady product improvement that make JOHNSON TAPPETS worthy of your consideration. Only proven materials, covering a range of steel, chilled iron, and various iron alloys are used in the manufacture of JOHNSON TAPPETS, providing greater strength, light weight and increased wear resistance. Serving the AUTOMOTIVE — AIRCRAFT — FARM — INDUSTRIAL — MARINE Industries.

"Tappets are our business"

JOHNSON JP PRODUCTS INC.

MUSKEGON, MICHIGAN

MELVILLE G. KENNEDY has been appointed vice-president of sales of Automotive Spring Corp. Kennedy formerly was associated with Ferro Stamping Co. in sales.

H. L. McCORMACK, who was supervisor of service training at the Caterpillar Tractor Co. in Peoria, Ill., has been made supervisor of the Sales Training Division of Caterpillar.

WILLIAM G. BURKET is now with the Goodyear Tire & Rubber Co. in Akron, Ohio. His work will consist of tire designing. Burket was formerly with the Dunlop Tire & Rubber Corp. as technical manager of tires.

H. M. CLARK, previously manager of the St. Louis Defense Division of Rayette, Inc., St. Paul, Minn., is now chief engineer of Federal Industries, Inc. in Detroit.

WALTER H. LOSSE has joined the Chevrolet Division of General Motors on the productive equipment staff. He had been staff assistant to the general manager of Bendix Aviation Corp. in the Missile Division, South Bend, Indiana. Before going with Bendix, Losse was 18 years with American Motors in the Nash Division.

EDGAR RUSSELL LOWER, JR. is now an industrial engineer with the Aluminum Co. of America in Davenport, Iowa. Lower had been in the Ballistic Research Laboratories at Aberdeen Proving Ground as a mechanical engineer.

TED A. MATERA has joined Westinghouse Electric Corp. at the Engineering Center in Pittsburgh as an associate engineer. Formerly, Matera had been a test engineer with Convair in San Diego.

WYN E. McCOY, formerly district manager of the Industrial Division of the Timken Roller Bearing Co., has been named sales promotion manager of the Division.

BRUCE J. McCOLL, who was a mechanical engineer with the woodlands section of Canadian Pulp & Paper Association, is now a consulting engineer with Pulp and Paper Research Institute of Canada in Montreal, Can.

G. R. MOORE, manager of the Valve Division of Thompson Products, Inc., has been elected a vice-president of Thompson Products. Moore joined Thompson as a parts salesman in 1931. He advanced through a series of regional sales positions, becoming manager of the company's largest automotive parts division in 1949.

ROLAND W. ST. AUBIN has been made maintenance coordinator for

CONTINUED ON PAGE 102

Aetna

America's No. 1 Producer of Clutch Release Bearings

For more than a third of a century Aetna Clutch Release Bearings have held recognized leadership in design, performance and dependability.

In terms of testimony, over 68,000,000 Aetna Clutch Release Bearings have been produced to satisfy the year-after-year demand of more than 50% of America's major producers of on-and-off-the-road mobile vehicles.

Research, a continuing Aetna program, has contributed more basic improvements, more feature "firsts" in Clutch Release Bearings than any other manufacturer.

Service records and laboratory breakdown tests (up to 1,500,000 de-clutchings) repeatedly prove the unmatched superiority of Aetna Clutch Release Bearings—in life-expectancy, lubricant retention and smooth, silent operating characteristics.

Take time—early in the planning stage, before "freezing" your designs—to test and compare world famous Aetna Clutch Release Bearings. Samples, quotations and complete engineering data are yours for the asking.

Aetna

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Manufacturers of: Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

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CHALLENGING OPPORTUNITIES
To men with a degree and an interest in

GYRO ASSEMBLY and TEST

Engineers who have a personal interest in precision mechanisms, where a high degree of accuracy is required ... men with pride in the precision of the product they help build.

You will constantly be doing development work and testing in one of the most versatile Laboratories in the country... working with the top men in the field and with the finest test, research and development facilities. We are in the process of a Major, Permanent, Expansion Program. New plant facilities being added in suburban Milwaukee area.

To aid you in your professional advancement AC will provide financial assistance toward your Master's degree. A Graduate Program is available evenings at the University of Wisconsin, Milwaukee.

GM's Electronics Division aggressive position in the field of manufacture and GM's long-standing policy of decentralization creates individual opportunity and recognition for each Engineer hired.

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Mr. John F. Heffinger
Supervisor of Salaried Personnel

AC Electronics Div.
General Motors Corp.
Milwaukee 2, Wis.

About SAE Members

Continued from page 100

American Airlines, Inc. He had been line maintenance supervisor.

St. Aubin was SAE Texas Section secretary for 1953–1954. He completed the unexpired term of **F. V. ESDEN** as chairman of the Section for 1954–1955

STEVEN B. WILSON, chairman of the board of Fram Corp., was elected honorary board chairman of Warner Lewis Co., a subsidiary of Fram. At the same time, **CHARLES B. BENTON** was made vice-president in charge of sales for Fram Canada Ltd.

ROBERT FRANK JENSON has been appointed accessory engineer of American Motors Corp. He has been an assistant accessory engineer for the corporation.

JOHN M. KAVANAGH is now branch manager and maintenance supervisor for Service Tractor Rental Co. He has been fleet supervisor for the Hegeman Farms Corp.

ROBERT E. HELMUS has been named distributor sales manager of Burndy Engineering Co., Inc. Previously he was a sales engineer of Pass & Seymour, Inc.

ALBERT F. VANDENBERGH has joined Ford Motor Co. in Dearborn as a product design engineer. He was previously with American Motors Corp. as a research engineer.

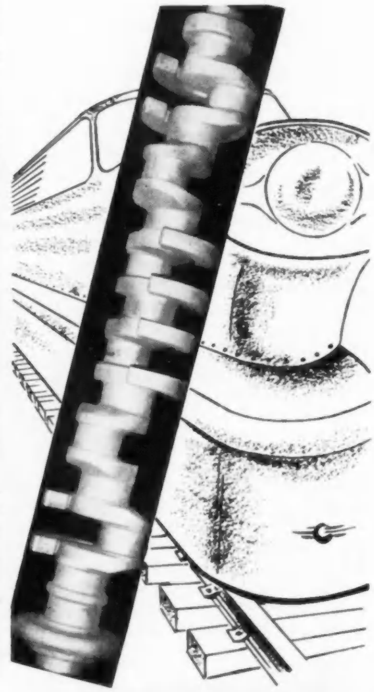
ROBERT H. FISCHER has joined Lago Oil & Transport Co., Ltd. in Aruba, N.W.I., Dutch West Indies, as an engineer. He formerly served with Bechtel Corp. in San Francisco.

GRANT S. WILCOX has been named plant manager of Ross Operating Valve Co.'s plant in Detroit.

Wilcox's experience ranges from assistant to general superintendent at Kelvinator Corp., assistant factory manager at Chrysler Corp.'s Plymouth Division to the subsidiary operations staff at Chrysler Corp.

THEODORE A. SUNDIN, who was assistant installations engineer at Lake Charles Air Force Base, is now installations engineer, First Radar Bomb Scoring Group, at the Carswell Air Force Base in Fort Worth, Texas.

MAJOR WILLIAM B. BOYD, formerly research and development administrator at the Wright Air Development Center, Wright-Patterson Air Force Base in Ohio, is now stationed with the Institute of Technology at Wright-Patterson.



PARK "DIE-FORGED" CRANKSHAFTS

help power the trains of tomorrow

The new entries in the lightweight train race are designed to solve the problem of mounting deficits in passenger operation by cutting original, operating and maintenance costs.

Park Drop Forge is proud that Park "Die-Forged" Crankshafts are specified for the diesel engines that power these trains of tomorrow.

HEAVY DIE FORGINGS SINCE 1907

Diesel Crankshafts up to 4000 lbs.
Crankshafts and Connecting Rods
Aviation and Marine Drop Forgings

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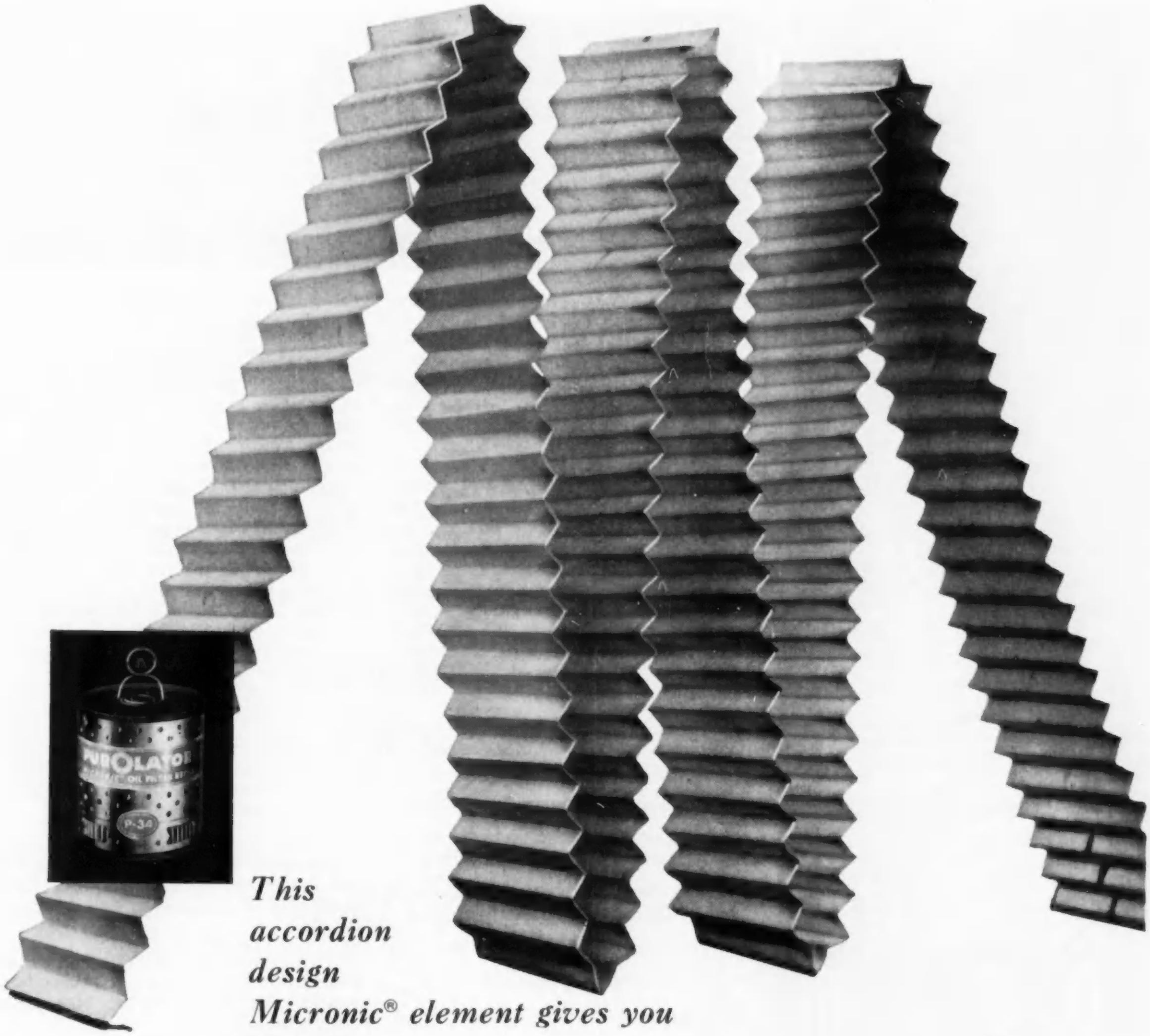

This accordion design Micronic® element gives you

10 times more filtration area for full engine protection

Pull out Purolator's accordion design and you'll see how Purolator packs 10 times more filtration area into its element than most filters. You'll find it provides maximum filtering area in minimum space, assuring *full* engine protection as no other filter can.

Controlled porosity of Purolator's Micronic® element filters out particles as small as .000039 of an inch, yet never removes costly additives in heavy-duty or detergent oils and never channels. The Micronic® element, made of plastic-impregnated cellulose, isn't affected by engine temperature, crankcase dilution, or water.

Engine manufacturers have proved time and time again that these wear-reducing features make an engine perform better and last longer. Find out how they can do the same job for you. Write for our new 32-page "Filtration Manual for Product Designers"—and please enclose 25¢ to cover postage and handling. Address Dept. A4-817

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SP News About Special Publications

KEEP UP-TO-DATE on the latest developments in Fuels and Lubricants. Everything from new additives to air pollution is discussed in this special publication (SP-139) which grew out of papers presented in Los Angeles, April 4, 1955. Price: $1.75 to members; $3.50 to nonmembers.

DO YOU NEED UP-TO-DATE NEWS ON PRODUCTION PROBLEMS? For the benefit of those who couldn't attend, the secretaries have extracted the most worth-while ideas as revealed at two production forums held recently at SAE national meetings.

One of these, held at the SAE National Production Meeting, Cleveland, March 19, 1956, produced ideas on the following subjects:

- To what extent should purchasing participate in the technical aspects of manufacturing?
- Manufacturing expense control.
- Indoctrination and training of college graduates for manufacturing.
- New burst of capital spending—new challenge to business planning.
- The customer's point of view.
- Forging of rare metals.
- Shell molding.

This special publication (SP-314) can be obtained by writing SAE Special Publications Department. Price: $1.50 to members; $3 to nonmembers.

The other, held in conjunction with the SAE National Aeronautic Meeting, New York City, April 9, 1956, produced ideas on these subjects:

- Manufacturing and engineering responsibility for reliability.
- Techniques of modern manufacturing management.
- Building reliability into aircraft control systems.
- Production planning for product availability.
- New trends in tooling.
- Quality control's role in product reliability.
- Automation and limited-quantity production.

This special publication (SP-315) can be obtained by writing SAE Special Publications Department. Price: $1.50 to members; $3 to nonmembers.

METHODS OF DETECTING AND MEASURING SEAMS IN STEEL are reviewed in a new SP containing the papers given at a symposium developed by the Committee on Methods of Detecting and Measuring Seams, of Division 30 (A) of the SAE Iron and Steel Technical Committee. This symposium was the first step taken by Division 30 (A) to carry out its purpose, which is "to establish ultimately on steels of many qualities seam depth standards, which will be usable by producers of finished steel." This report contains the following papers:

1. "Survey of Available Methods," by C. H. Hastings, Watertown Arsenal.

2. "Application of Ultrasonic Inspection to Detection of Seams in Steel Products," by John C. Smack, Sperry Products, Inc.

3. "Use of Eddy-Current Instruments with Circumferential Coils for the Inspection of Barstock and Tubing," by J. M. Callan, Magnetic Analysis Corp.

4. "Magnetic Particle Inspection as a Means of Detecting and Measuring Seams," by A. K. Saltis, Magnaflux Corp.

5. "Seam Depth Indicator," by W. A. Black, Republic Steel Corp.

6. "Magnetic Seam Detectors," by E. F. Weller and F. W. Chapman, GMC.

This special publication (SP-144) is available from SAE Special Publications Department. Price: $2 to members, $4 to nonmembers.

NEW AID FOR INSPECTORS OF SHEET STEEL and others interested in visible imperfections in this material is a booklet compiled by Division 32—Designation and Terms of Sheet Steel of the SAE Iron and Steel Technical Committee. This manual, produced in handy pocket size ($5\frac{1}{2} \times 8\frac{1}{2}$), contains photographs of 25 of the most common imperfections in sheet steel visible to the naked eye. Included with each photograph is a definition of the imperfection being shown. This booklet (SP-145) is available from SAE Special Publications Department for $1.75 to members; $3.50 to nonmembers.

Do your present truck heaters have a ----

PARTS

"Repair or Replace"

WARRANTY

good for one year or

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miles?

EVANS

custom-designed truck heaters have it!

Your Evans Truck Heaters *have* to be good! To prove it, Evans backs every single heater they build with a full year—or 50,000 mile—warranty (whichever occurs first). This is your assurance—and your *customers'* too—that Evans Heaters are the *right* heaters for the trucks you build.

What's more, the heaters Evans engineers design and custom-build for you will meet *all* your truck requirements. They will fit *right*—for quick, easy installation. They will deliver all the BTU's needed for maximum driver safety and comfort—under *any* weather conditions. And special, heavy-duty construction means that the owner gets longer service with much less maintenance.

There's an Evans Heater for *every* type commercial vehicle, from local panel delivery truck to giant over-the-road haulers. Why not let Evans solve your truck heating problems, whatever they may be?

FREE Consulting Service and Heater Catalog! At no cost to you, one of our engineers will call to discuss your heater problems for any truck model, present or future. And write now for your free Evans heater catalog! Address: Evans Products Company, Dept. Z-8, Plymouth, Michigan.

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EVANS PRODUCTS COMPANY
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Integrated Flight Systems Make Progress

Based on paper by

BEN F. McLEOD
Pan American World Airways, Inc.

DEMAND has been urgent for systems which would fit together in logical form the ever growing airborne aids for flight guidance and automatic flight control.

After the close of World War II, new flight control aids became standard equipment on many airlines. Most common were electronic automatic pilots and electronic compass systems, electric artificial horizons, radio magnetic indicators (RMI), and localizer and glide slope receivers. Then came the adoption of the Instrument Landing System (ILS) and the very high frequency omni range (VOR) system. About 1948 Sperry introduced the "Zero Reader," now called the flight director. The flight director brought the need for a steering indicator, heading selector, and function switch.

The flight director requires heading, pitch, roll, and radio information; so does the autopilot. The VOR system requires magnetic heading information in order to provide a display on the RMI. The newly introduced weather radar requires pitch and roll information. The human pilot requires a display of heading, pitch, roll, radio information, altitude, air speed, and more.

From the foregoing it can be seen why there was need to fit together boxes, instruments, and simple systems so that components of the composite system would take logical order, and how the integrated flight system came to be.

Integrated flight systems are now being produced by Collins, Sperry, and Bendix, and other companies have them under development. These systems are designed to provide, with a minimum number of elements, the following functions:

1. Automatic flight control during cruise and approach conditions.
2. Computed steering information for the pilot.
3. Aircraft attitude and heading information.
4. Radio position information.

Some changes in instrumentation may be required when equipment for automatic landings becomes satisfactory. Present day instrumentation does not take into consideration automatic communications or automatic air-to-office control. A new array of aids for long range navigation seems to be just around the corner. (Paper "Integrated Flight Systems" was presented at SAE National Aeronautic Meeting, New York, April 11, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Radar Defenses Pushed Seaward by U.S. Navy

Based on paper by

REAR ADMIRAL A. K. MOREHOUSE

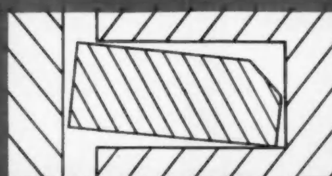
THE Navy is contributing to continental air defense in three general areas:

1. The extension of the contiguous radar coverage system by use of picket ships and lighter-than-air aircraft (when the latter become available).

2. Augmentation forces of Naval and Marine interceptor aircraft to assist

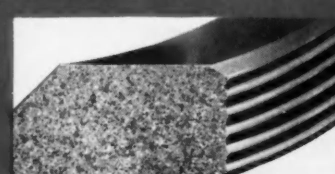
It takes more than chromium to make a fine Sealed Power chrome-faced compression ring

THE DESIGN MUST BE RIGHT



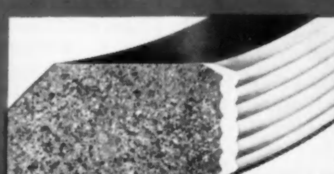
There are many different designs for Sealed Power compression rings. Each was worked out in close collaboration with the designers of the engine in which each ring is to work. Only after weeks of laboratory and actual road testing is any design released for production.

It has been truly said that no chrome-faced ring can be any better than the casting which is its foundation. Sealed Power uses a special chrome-alloy ring iron, perfected by Sealed Power metallurgists for ideal bonding quality as well as all other properties required of a good ring iron.



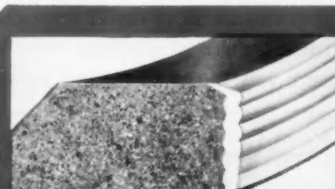
THE IRON MUST BE RIGHT

THE PLATING MUST BE RIGHT



Electro-plating of the heavy solid chrome face on Sealed Power compression rings is done by a process devised by Sealed Power. Not only is the plating thicker than most, but it is so firmly bonded that there is not the slightest chance of chrome particles flaking off to damage the cylinder wall.

Every Sealed Power chrome-faced compression ring is lapped to a light-tight finish to insure quick seating and immediate oil control—with microscopic oil-retaining grooves machined into the face of the casting to insure good lubrication in the hottest, driest location.



THE FINISH MUST BE RIGHT

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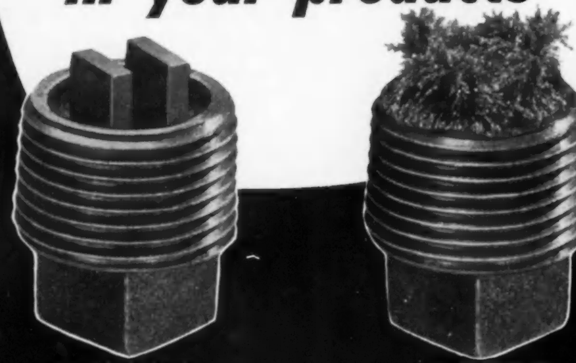

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The "before" and "after" views above, show the amount of abrasive metal pulled from a typical gear housing by the powerful magnet in a Lisle Magnetic Plug. Removal of this abrasive metal from the lubricant will lengthen the life of precision moving parts in the equipment you make. You can prove it for yourself!

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LISLE Corporation

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the regular ADC forces under the operational command of CINCONAD.

3. The seaward extension of the Distant Early Warning Lines. In the Pacific, the warning line will extend southward from the Alaskan area. In the Atlantic it runs southeast from Canada.

(Paper "Your Air Defense" was presented at SAE Southern California Section Meeting, May 9, 1955.)

Brightness Contrast Makes Runways Visible

Based on paper by

CAPT. NORMAN LEE BARR

LT. JG. THOMAS A. HUSSMAN, JR.

and

LT. JG. JAMES F. PARKER

Naval Medical Research Institute

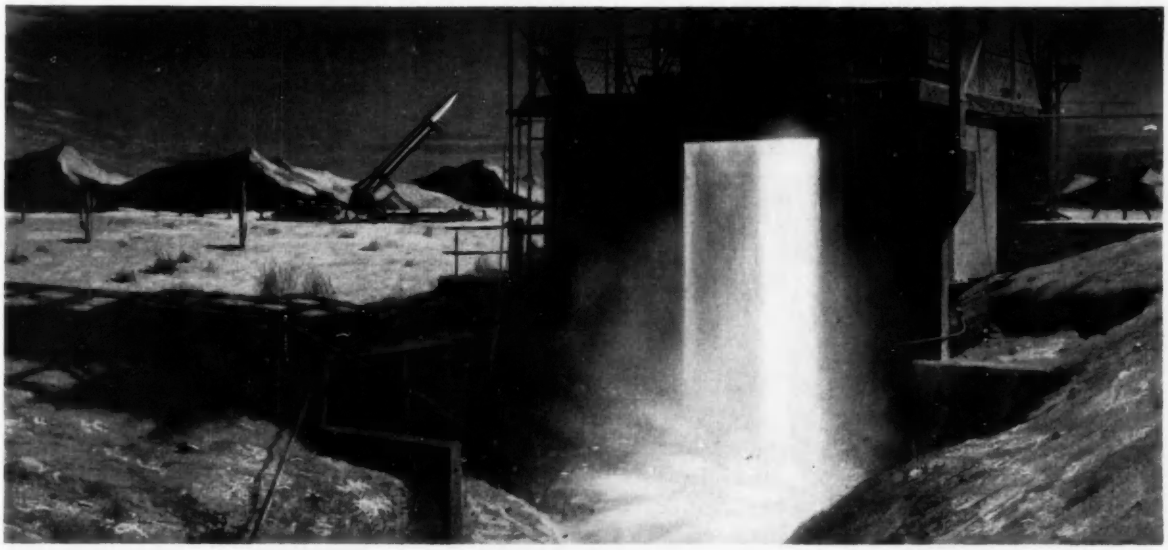
BRIGHTNESS contrast, color contrast, and texture differences are the three factors of primary importance to an observer in discriminating an object from its background. Brightness contrast is the determining variable in detection at great distances because all colors fade toward a neutral gray as distance increases. This fading is due to filtering and scattering of light coming from the reflecting surfaces and to atmospheric haze along the path of sight. Detection based on texture differences is possible only at short distances where the textural size subtends an angle larger than the limiting visual acuity threshold angle for size. This is in accord with the experience of aviators that high contrast runways become visible farthest out on the approach path, runway markings and numbers become visible next, and texture differences become apparent last.

Recent experimental work indicates the average working contrast threshold to be approximately 0.05. Many runways have contrasts with their backgrounds that fall below this value. A concrete runway against an earth background will yield the highest contrast, -1.175. The customary background, grass, will yield a contrast of 0.045 against an asphalt runway. This is below the currently used threshold value of 0.05.

To show how visibility can be improved by choice of the proper runway material we can cite as an example an asphalt runway with a grass and soil

Notable Achievements at JPL

THE CORPORAL ROCKET ENGINE, developed at JPL, represents the first large-scale American engine to be used in a tactical guided missile and the first significant step in the design of truly lightweight, large-scale rocket engines. The reliability of the Corporal engine has been proven in hundreds of static tests and flights.



Pioneers in Rocket Engine Development

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- APPLIED MECHANICS
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- TECHNICAL EDITING
- TECHNICAL WRITING

The development of efficient rocket power plants involves application of knowledge from many scientific and engineering fields—thermodynamics, combustion, heat transfer, fluid mechanics, and metallurgy, to name a few. Such development stems from experience gained with small engines and progresses through various phases, including component development, heat transfer investigation and exhaustive firing of the final engine to assure reliability and repeatability of operation.

The prime objective of JPL is obtaining basic information in the various sciences related to missile systems development and in all phases of jet propulsion. As a basis for the entire Laboratory activity, a major continuous program of fundamental research in the physical sciences is constantly in progress.

The Laboratory, occupying an 80 acre site in the San Gabriel mountain foothills north of Pasadena, is staffed by approximately 1450 people, all employed by the California Institute of Technology. Its various projects are conducted under continuing contracts with the U. S. Government.

Expanding programs are rapidly providing new openings for qualified people. If you would enjoy the challenge of new problems in research, write us today outlining your interests, experience, and qualifications.

CALTECH jpl JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

background which has an inherent contrast of 0.169. If this runway should be re-surfaced with Keenes White Top cement, the contrast of runway against background would be increased to – 7.17, and visibility of the runway would rise from 0.2 mile to over 0.9 mile. (Paper "The Visibility of Airport Runways" was presented at SAE National Aeronautic Meeting, New York, April 11, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

What Is Best Drive For Accessory Power?

Based on paper by

RICHARD L. McMANUS

General Electric Co.

THE trend to alternating current power at constant frequency for aircraft has created a need for constant speed drives to generate this power. The fact that some manufacturers are designing aircraft to use a pneumatically driven air turbine while others favor a hydraulic constant speed drive from the engine is ample proof that no universal answer has been reached as to the optimum system.

Our investigations indicate that as each new airplane enters the preliminary design stage, or whenever a major design change is made, it is necessary to make a thorough system analysis. And from these same investigations certain conclusions are drawn:

1. Accessory power system installed weight is usually lower for the pneumatic system than for the direct driven system.

2. Fuel penalty is generally more costly for pneumatic than for mechanical power extraction. As fuel penalties become more nearly equal, the pneumatic system becomes optimum.

3. The direct driven system is generally heavily penalized by the drag consideration. The drag penalty is always less for the pneumatic system.

4. Neither system is optimum in all cases. There is no universal answer.

It is strongly recommended that a thorough system analysis, utilizing the three parameters—installed weight, fuel weight for power extraction, and drag—be conducted on each new airplane design to select the optimum accessory power system. (Paper "Pneumatic vs. Mechanical Power Extraction for Aircraft Accessories" was presented at SAE National Aeronautic Meeting, New York, April 12, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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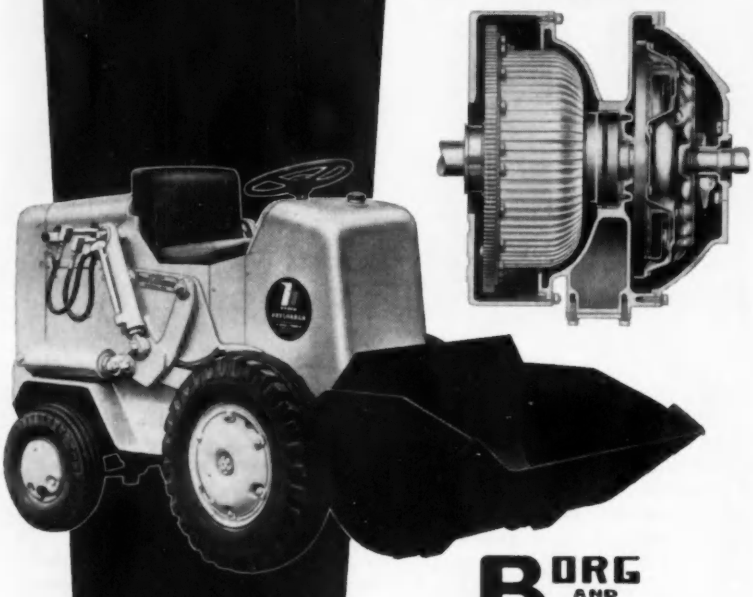

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BORG & BECK DIVISION

BORG-WARNER CORPORATION
Chicago 38, Illinois

Nike Excels As Defense Weapon

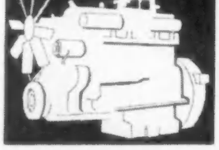
Based on paper by

COL. EVERETT D. LIGHT

Army Anti-Aircraft Command

NIKE, the 20-ft radar guided rocket, is doing everything it was designed to do and more. It intercepts its prey at high altitudes and has an accuracy never previously dreamed of in anti-aircraft weapons. Its radar control system locks it to its victim until it gets close enough to destroy the intruder.

Each Nike battery requires a control area and a launcher area. The control area where the radars and computer are located covers approximately 8



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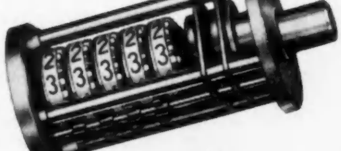

Rev-Counter especially designed for built-in installations.

That's right . . . you can build into your engine a real "performance-prover" that keeps a faithful and complete record of engine use . . . a record that's beyond dispute. These Veeder-Root Rev-Counters *show you and your customers*, at any time, exactly how your equipment is performing up to its guarantee . . . whether they're getting out of it all the service you built into it. These direct counter-readings also show at a glance when routine maintenance is coming due . . . whether servicing is needed . . . and supplies other valuable facts-in-figures.

This 2-way protection is vital not only as a built-in feature of engines, but also of generators, compressors, heaters, refrigerators, high-speed cameras, and what have *you?*

Veeder-Root Rev-Counters are available with *tachometer take-off* . . . and may be geared to your own engine requirements. Count on Veeder-Root for any assistance you need in designing these Rev-Counters into your product. Write:

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STOCKS OF STANDARD COUNTERS AVAILABLE AT

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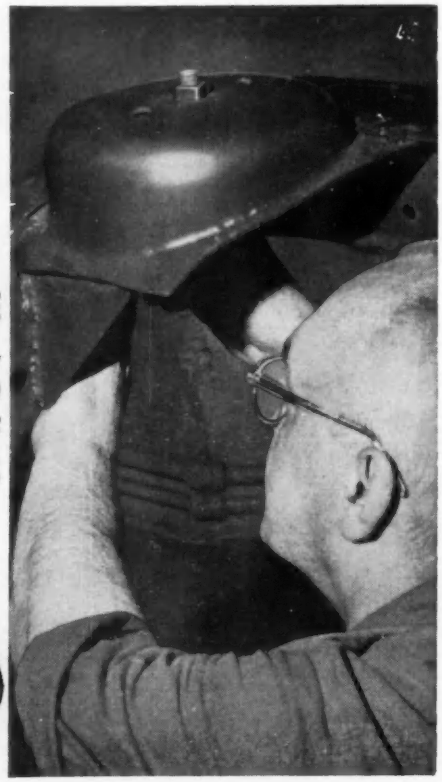
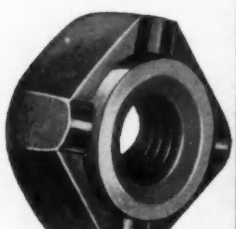


SPEED UP THE FABRICATING, FASTENING AND ASSEMBLING OF METAL PARTS WITH



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Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

They're just the ticket for those hard-to-get-at places. And they stay put—will not work loose or rattle.

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acres. The area between the control and launcher areas is needed for line of sight and to lay connecting cables. Equipment characteristics call for this distance to be between 3000 and 16,000 ft. The launcher area requires 43 acres.

A typical launcher area consists of three underground magazines with four launchers each—one on the elevator and three above-ground unrevetted launchers. All existing batteries will accommodate the future Nike missile. Land purchased will also accommodate three more underground magazines (3 acres only) to be constructed at a later date.

The site also includes a battery assembly area where the major components are joined and the ready missiles fueled. Troop housing is now located at the site, and some family housing for key personnel has been requested recently.

Nike defenses are at various stages of completion in 13 cities; many of them are already operational. In the near future almost all of them will be at combat readiness. There will also be more than 100 other sites, and as more and more equipment becomes available, the Army will have Nike defenses around other major cities. (Paper "Your Air Defense" was presented at SAE Southern California Section Meeting, May 9, 1955.)

Drive Line Choice Is No Simple Matter

Based on paper by

JOHN BORLAND

Wisconsin Axle Division, Rockwell Spring and Axle Co.

THE only difference between the conventional drive line and the automatic drive line as applied to earthmoving equipment lies in the transmission and clutch group. Why, then, should the conventional type be used at all when the newer types are available?

Automatic or power-shifted transmissions used in conjunction with torque converters make for easier operation. Less skill is required by the operator and there is less risk of damage by unskilled operators. Yet despite these advantages, there are many things which favor the conventional drive line.

Lower initial cost is the first advantage. Conventional units have many fewer parts and there is less need for close tolerances in manufacture.

Conventional transmissions are sim-

Judge a Product by its Users

Newest Navy supersonic fighter is the slim, trim Chance Vought F8U-1 Crusader. In keeping with the F8U-1's advanced design is its use of Aeroquip 601 Lightweight Engine Hose for oil, utility and power control systems; and 617 Lightweight Air Frame Hose for suction lines.

Aeroquip

REG. TRADEMARK

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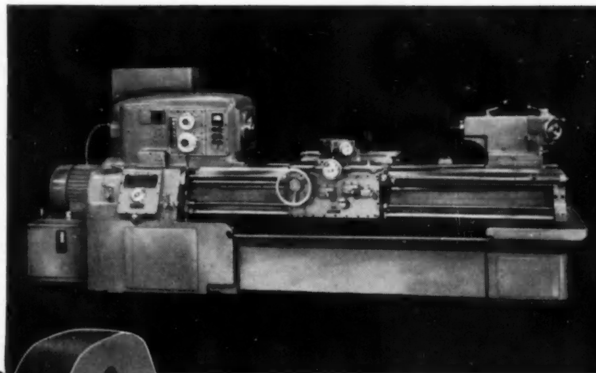
Local Representatives in Principal Cities in U.S.A. and Abroad. Aeroquip Products are fully Protected by Patents in U.S.A. and Abroad.

USED ON MONARCH LATHES—The Monarch Machine Tool Co. uses a Pesco Reversible Pump to provide hydraulic power on its Series 62 and 80 lathes for headstock shifting and four-way power rapid traverse, and on the Series 90 lathes for head-stock shifting. Pump is belt driven by main drive motor (left).



PESCO REVERSIBLE HYDRAULIC PUMP—Model 051001-170. Gear type, positive displacement pump delivers 3.6 gpm at 1800 rpm and 1000 psi. "Pressure Loaded"* bearings assure longer service life and higher efficiency.

unique Pesco Hydraulic Pump has

one-way flow... regardless of rotation!

No matter which way you rotate this new PESCO Hydraulic Pump, flow is always in the same direction—inlet and outlet ports do not change! Startling? Yes . . . but it is typical of the valuable contributions now resulting from PESCO's creative engineering.

This PESCO pump is the answer for applications having a dual rotation power source, but requiring single direction hydraulic flow. On machine tools, for example, it can be run off the main drive motor to provide constant hydraulic power regardless of rotation. And for power take-offs on trucks and tractors, this pump gives correct flow independent of rotation.

Where can you use this pump? Samples are in stock and available to original equipment manufacturers for testing. Production requirements can be met promptly. For detailed information or specifications, contact your nearest PESCO sales engineer, or write: PESCO, 24700 North Miles Road, Bedford, Ohio.

PESCO's patented principle of gear pump construction

engineering Pesco production

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Producing the Best in Hydraulic Pumps, Fuel Pumps, Electric Motors and Axial Flow Blowers

ple in design and easily understood by the average mechanic. Therefore, they are more easily maintained. The design also makes it possible to obtain various ratios in the same box without changing any basic tooling.

Certain types of earthmoving machinery require close control of ground speeds. In a drive line with a spring-loaded clutch, a conventional transmission, and the engine running at a governed speed, this speed control is obtained with relative ease. On the other hand, in the case of an automatic transmission with a torque converter in the drive line, a certain amount of rubber is present which makes difficult the accurate control of ground speed. (Paper "Conventional Drive Lines As Applied to Earthmoving Machinery" was presented at SAE Central Illinois Earthmoving Industry Conference, Peoria, April 3, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Still Better Metals Sought for Jet Engines

Based on paper by

DEAN K. HANINK

Allison Division, General Motors Corp.

THE Allison T56-A-1 gas turbine illustrates engineering problems which to the materials engineer are common to turboprop and turbojet. Here, to meet various engine requirements, materials range from light alloys through medium alloy, ferritic, and austenitic stainless steels—including super grade alloys.

The air inlet housing of the T56, which is a magnesium casting, is given a corrosion resistant coating produced by Allison and called "HAE." It provides a surface layer composed primarily of a stable magnesium oxide 0.001 to 0.0015 in. thick. Care must be exercised in processing to see that air pockets are eliminated lest the coating fail to form. If there are indications of porosity, the deficiency can be overcome by sealing or soaking the HAE with suitable silicone base lacquer.

Popular materials for blading and wheels have been those in the AISI 400 series grades. Current Allison practice on rotating blades forged and precision machined from AISI 410 steel is to air harden from 1650 to 1700 F, followed by tempering at 950 F. Bench testing has proved the advantage of an air hardening treatment from 1750 F and tempering to a nominal hardness of Rc 30 providing the finishing or polishing operation is followed by a stress relief treatment of 950 F. More recent work with materials containing about 3 to 4% nickel, which will require deep freeze and temper for heat-treatment, shows considerable promise for compressor blading application.

Steels selected for the compressor wheels make up a GM patented assembly consisting of 14 stages, each wheel splined to the adjacent integral spacer at the wheel periphery. Since the shaft splines engage only the first and 14th stage wheels, these two forgings are produced from AMS 6260 or 9310 steel carburized at these two locations. Corrosion protection is provided by electroless or immersion nickel plating, a coating which consists of 7 to 10% phosphorus. A plating thickness of 1.00 to 1.25 mils is sufficient.

The cannular construction of the combustion section employs AISI 310 or 25-20 stainless steel inner liners. By cooling the outer wall, the com-

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... NEW ... but *proved* for positive protection against overloads and short circuits in low-voltage electrical equipment!

Yes, Fasco's new "1133" is now accepted as a standard safeguard for motors used in such applications as actuating seats, window-lifts and windshield wipers. Leaders in the automotive field regard its unique ability to protect low-voltage electrical equipment ... and its dependability ... as proof that it pays to

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bustion case can be fabricated from SAE 4130 sheet with electroless nickel plating.

Exit gas temperatures or inlet temperature of combustion gases from the transition section of the liners may be in excess of 1900 F. This dictates the use of super alloys throughout the blading and vanes of the turbine. Special attention was paid to the selection of alloy with very high creep resistance in the first three stages and the best fatigue properties for the fourth stage which operates at a relatively low temperature. The turbine blade alloys used in this engine are not considered at present to be the prime limiting factor in raising temperatures for improved performance.

There seems to be general agreement that the targets for future engines are:

1. Cheaper and more corrosion resistant steels for compressors which will operate in a temperature range up to 1300 F.

2. Improved high temperature sheet materials of equivalent cost and alloy content.

Apparently there are two choices in the latter target—alloys of high manganese with nitrogen austenitic stabilizer, or alloys which depend upon aluminum and titanium hardeners as a result of solution and precipitation heat-treatments. In recent months attention has been directed toward improvements (A-286, for example) in melting and ingot practice at the melt shops to bring these materials into large scale commercial production, making their higher strength modifications a practicality.

Intense efforts to produce this somewhat difficult-to-make alloy, which has adequate hot strength with low critical material index, are the full recognition of importance attached to conserving this country's scarce and expensive alloying elements in the high temperature steels. (Paper "Engineering Requirements for Jet Engine Materials" was presented at SAE Annual Meeting, Detroit, Jan. 10, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Magnesium Castings Salvaged by Welding

Based on paper by

W. A. BECK

The Dow Chemical Co.

ARC welding is the recommended process for weld-repairing magnesium aircraft castings. At the Dow Foundry we favor a d-c welder because it gives a quieter weld puddle and so makes repair easier. An a-c welder will give deeper penetration but this is unnecessary with castings.

The d-c welder is hooked up as direct current reverse-polarity. In this type of welding the electrode is positive and the work negative. Thus electrons flow from the plate or workpiece to the electrode. It has a so-called plate cleaning effect which is beneficial to the welding of magnesium. Presumably the electrons leaving the plate and the gas ions striking the plate tend to break up the surface oxides, scale, and dirt usually present.

A foot control is almost a necessity for successful repair at high efficiency rates. Most cracks which occur in castings start at the instant the arc stops. To overcome this, welding of the area is continued until the complete weld repair is finished, once the arc has been struck. Then on completion of the weld, the operator eases back on his foot controlled amperage controller and gradually fades out the arc until it dies away. This prevents great thermal shock when the arc is stopped.

When the welding is properly done,

"Rhino" meets rugged demands of line maintenance work. Driving front axle and other vital parts made from nickel alloy steels. The "RHINO" is produced by The Four Wheel Drive Auto Co., Clintonville, Wisc.

Driving safety boosted in new pumper series. Steering made easier, cornering improved. FWD toughens components by making them of nickel alloy steels.

How ready-made steels boost ratings

9500 POUNDS... that's the rating of the live front axle on this FWD "Rhino." Stronger than the usual truck axle by 50%, it safely takes stress and strain from front-mounted derrick and digger.

Built to handle work far beyond the scope of a conventional truck, FWD vehicles need extra stamina, obviously. And to obtain it, FWD's engineers specify standard grades of nickel alloy steels. Grades that show how you, too, may boost ratings.

For example, nickel-chromium-molybdenum axle shafts of 4337 and main transmission shafts of 4340 withstand shocks, fatigue and multiaxial stresses. Furthermore, these steels readily respond to fabrication and heat treatment.

Carburizing grades... 4820 or 4620 for transmission gears, and 4620 or 8720 for transfer case gears... provide the combination of strength and toughness that means hard, wear-resistant surfaces supported by strong, tough, shock-resistant cores.

For extremely high toughness and strength in differential ring gears and pinions, FWD specifies Krupp 4% nickel 1½% chromium steel.

Whatever your product, when you face questions about metal let us give you the benefit of our wide practical experience. Write for List A of available publications. It includes a simple form that makes it easy for you to outline your problem.

Power to spare in roughest kind of going. FWD road maintenance trucks utilize nickel alloy steel parts for essential stamina as well as wear-resistance.

One-man cab unit allows 10% more cargo space. Thanks to weight-saving rear axles and scientific weight distribution. Strength gained by using nickel alloy steels permits the extra payload.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

the weld metal is dense and fine grained and there is a minimum heating effect on the adjacent metal. The usual weld efficiency in sound metal is around 90%. Tests on the strength of helium arc-welded butt joints in cast Dowmetal H alloy and C alloy have shown weld efficiencies of 90 to 100%, where the efficiency is based on the strength of the original metal in the same condition of heat-treat.

Poor welding practice may lead to three particular conditions which could lower the physical properties of the metal adjacent to the weld. These are: (1) cracking, (2) incipient fusion, and (3) grain growth. Cracks generally originate in the metal adjacent to the weld and extend into the weld metal. They are caused by stresses from heating and cooling of the metal when welded. They follow grain boundaries and will follow weaknesses like incipient fusion and microshrinkage voids if these are present. Incipient fusion occurs when the low melting constituent in the cast metal melts, spreads out in thin layers along the grain boundaries, and resolidifies in that location. Grain growth is caused by prolonged heating during welding, and is helped by the stressing of the metal during welding and cooling. It may occur during the solution heat-treatment following welding.

The three conditions can be avoided by (1) good welding practice to avoid thermal shock (and using alloys of a wide melting range), (2) avoidance of prolonged heating in one spot during welding and multiple passes, where possible, and (3) careful heat-treatment following recommended practice. (Paper "Weld Repair of Aircraft Quality Magnesium Castings" was presented at SAE Annual Meeting, Detroit, Jan. 11, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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DESIGN: Working knowledge of hydrodynamics, gas dynamics and applied thermodynamics as related to nozzles, turbines, pumps and control systems. Involves the application of systems engineering concepts in analytical integration of components into compatible propulsion systems. Broad field: evaluate new engines; solve special problems in compressible and incompressible flow, combustion, heat control; develop prediction techniques for exceptional operating conditions.

EXPERIMENTAL: Sound background in hydrodynamics and thermodynamics required, with 5 years related experience, preferably propulsion. Plan performance experiments; study efficiency of systems; relate results to basic fundamentals of present models' operation, apply findings to future engines.

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A DIVISION OF NORTH AMERICAN AVIATION, INC.

New Members Qualified

These applicants qualified for admission to the Society between June 10, 1956 and July 10, 1956. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Alberta Group

George A. C. Higgs (A), Lloyd O. Lundquist (A).

Atlanta Section

Charles R. F. Beall, Jr. (J), J. Forrest Collins, Jr. (M).

Baltimore Section

Richard D. Petersen (J), John N. Schweikert (J).

Buffalo Section

George E. Millet (M).

Canadian Section

Francesco G. Bonmartini (J), Samuel G. Curtis (A), James S. Hart (J), Robert L. Mitchell (A).

Central Illinois Section

Lyle E. Eaton (M), J. E. Staab (M), James Patrick Welsh (J).

Chicago Section

Herbert J. Germann (M), Denver C. Hamman (M), James M. Hutchinson (A), Robert E. Lake (M), Milton M. Paluch (M), Marvin Scadron (M), Raymond Suchomel (M), Joseph J. Wylie (A).

Cincinnati Section

Everett W. Denison (M).

Cleveland Section

Ted R. Diegel (M), Paul R. Houser (J), Donald J. Kreml (A), Frederick J. Port (M).

Colorado Group

Russell Hofen (M).

Detroit Section

George T. Ansen (M), A. F. Bauer (M), Gerald Bogacki (A), Frank J. Bognar (M), Donald W. Bridges (J), Albert W. Carion (J), George F. Dixon (J), Gene R. Dunifon (M), Edward J. Dzenko (M), Francis K. Fermoyle (A),

three Steps to Better* Waste Disposal

with B-W LOAD LUGGER® SYSTEM

*** EASIER · FASTER · MORE ECONOMICAL**

Conventional methods of handling spent materials, scrap, rubbish and other plant waste take a lot of time, work, manpower and equipment. A costly, inefficient operation at best.

But with Borg-Warner's Load Lugger System, waste disposal is easy, fast, economical. One Load Lugger equipped truck, plus detachable Load Lugger containers, does the work of several conventional trucks. That greatly reduces investment in equipment, cuts manpower requirements, lowers operating and maintenance costs.

With specially designed containers, the Load Lugger System handles all types of materials—solids, liquids, gases. Hauls from 1½ to 14 cubic yards of material. Takes loads to 18,000 pounds.

What's more, the Load Lugger can be used to self-load and haul heavy equipment, pipe or other long or bulky pieces. Flat bed hoist bodies mount on any truck chassis of suitable capacity, with controls installed in cab for easy, one-man operation.

A product of B-W's Ingersoll Kalamazoo Division, the Load Lugger System is another typical example of Borg-Warner's "design it better—make it better" tradition. In this way, with hundreds of products, Borg-Warner serves American industry every day.

Almost every American benefits every day from the products of

BORG-WARNER

ENGINEERING B-W PRODUCTION

THESE UNITS FORM BORG-WARNER, *Executive Offices, 310 S. Michigan Ave., Chicago.* **DIVISIONS:** ATKINS SAW • BORG & BECK • BYRON JACKSON CALUMET STEEL • DETROIT GEAR • FRANKLIN STEEL • HYDRALINE PRODUCTS • INGERSOLL CONDITIONED AIR • INGERSOLL KALAMAZOO • INGERSOLL PRODUCTS • INGERSOLL STEEL • LONG MANUFACTURING • MARBON CHEMICAL • MARVEL-SCHEBLER PRODUCTS • MECHANICS UNIVERSAL JOINT NORGE • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR • WOOSTER DIVISION YORK • **SUBSIDIARIES:** B-W ACCEPTANCE CORP. • BORG-WARNER INTERNATIONAL • BORG-WARNER, LTD. • BORG-WARNER SERVICE PARTS • LONG MFG., LTD. MORSE CHAIN • MORSE CHAIN OF CANADA, LTD. • REFLECTAL CORP. • WARNER GEAR, LTD. • WESTON HYDRAULICS, LTD.

ALBADURE*... the steel tape with lasting legibility

Here is a steel tape that stays clear and legible long after markings on other tapes have worn off.

An amazingly tough plastic coating on both sides of the line protects the white background, the graduations and numbers on ALBADURE tapes, giving their surfaces tremendous resistance to abrasion and corrosion. To quote a State surveying party report, "If ALBADURE stood up in this tough mud and sand, it'll stand up anywhere." Available in all standard lengths, widths and graduations, in cases and on reels.

PHOENIX WYTEFACE®... the woven tape that outlasts others 3-1

PHOENIX WYTEFACE (non-metallic) Woven Tapes made from extra strong synthetic yarns, are harder wearing, with higher tensile strength and dimensional stability than ordinary woven tapes. A special plastic coating on both sides protects the line against hard use, water, stones or brush.

The end of the line is enormously strengthened by a lamination of Flexi-Foam, a spongy plastic-rubber. No stitches or hinge point to weaken the line.

A Highway Engineer reported of the non-metallic PHOENIX WYTEFACE, "It has at least three times the life of an ordinary metallic tape." *Ask Your K & E Dealer!*

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89 YEARS OF LEADERSHIP In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

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New Members Qualified

Continued

Roy W. Fogle (J), Alexander Georgeff, Jr. (A), Thomas V. Godsil (M), Douglas C. Harding (A), Bill J. Hemenway (M), James W. Houston (M), Louis J. Hroba (J), Paul M. Jensen (M), Max S. Johnson (A), John L. King, Jr. (M), Hugh W. Larsen (M), Edward B. Lassila (J), Elwood W. Lewis (M), John G. Locklin (M), James G. Maier (M), Jack E. Maxwell (A), Marshall M. Meads (J), Harold D. Michel (J), Henry B. Mullholland (M), Leon B. Musser, Jr. (M), Joel M. Opsomer (J), Thomas H. Poyer (J), Casimir S. Rejent, Jr. (A), Edward B. Rials (J), Louis Robert Ross, Jr. (J), Robert D. Ruger (M), Roger J. Schroeder (J), Howard R. Stevens (J), John R. Stone (M), Jerry M. Strang (J), Albert E. Vandermarliere (J), Richard D. Vartanian (M).

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Milwaukee Section

Jerome J. Ahne (J), Ralph L. Bauer (M), R. S. Stevenson (M).

Montreal Section

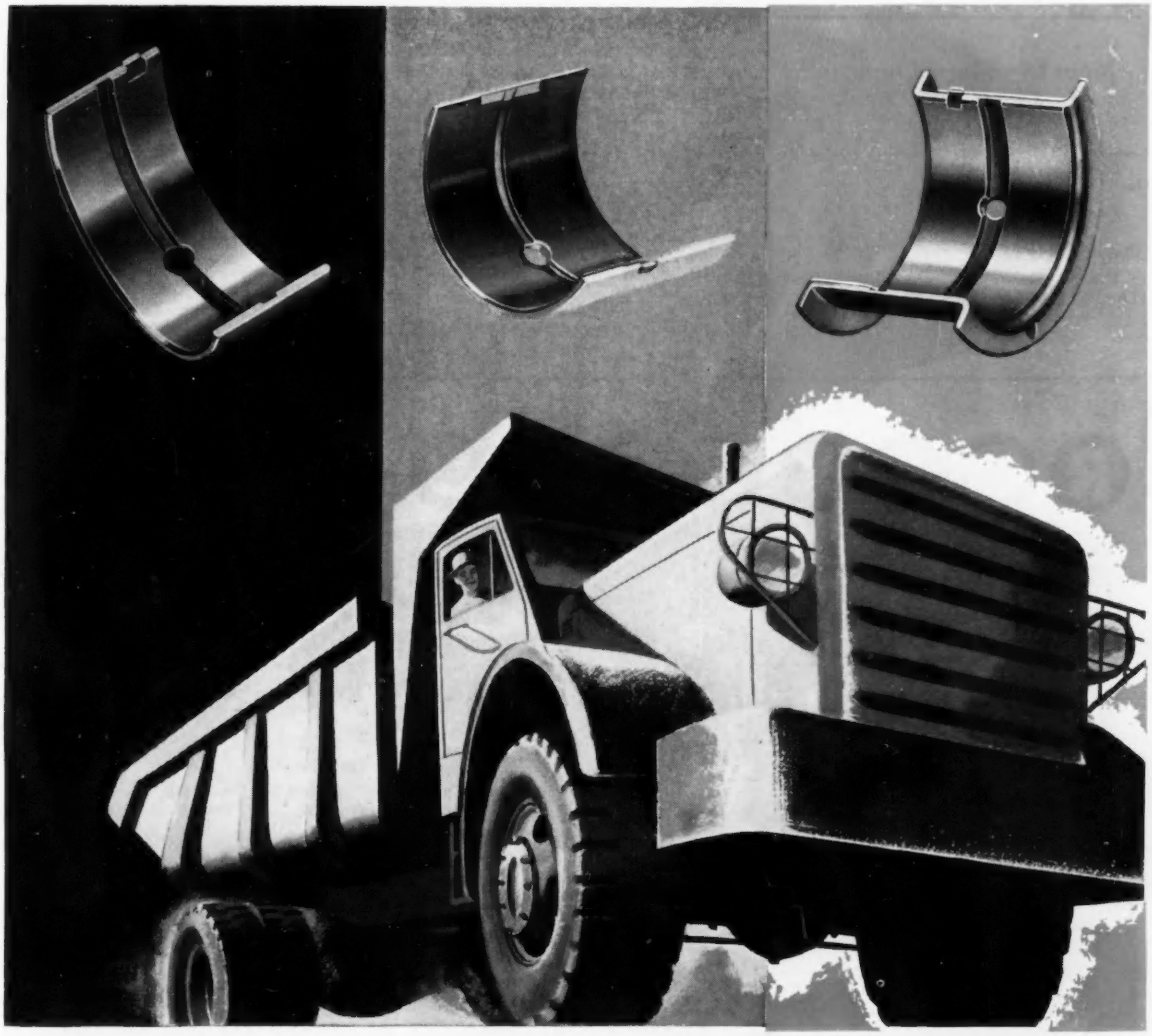
C. R. Curtis (A), Charles D. Parmelee (J), William E. Rose (M).

New England Section

James F. Jefferson (A).

Northern California Section

Robert E. Totman (J).



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High-speed, high-temperature, heavy-duty engines are a real test of engine bearing performance. To meet these requirements calls for watch-like precision in bearing production, with continuous test-and-inspection at every major step in manufacture. With over half a century's specialization in sleeve bearing production, by the thousand or the million, we are equipped to meet these modern requirements.

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SINCE 1899

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Texas Section

James W. Callahan (M), William C. Howard (A), Frank B. Whalen (A).

Texas Gulf Coast Section

R. F. Nelson (M).

Washington Section

Frank R. Caldwell (M), Vice Adm. Charles F. Coe, USN, Ret. (M).

Western Michigan Section

Morris V. Dadd (M), Kenneth W. Lesher (M).

Williamsport Group

Raymond A. Breining (J).

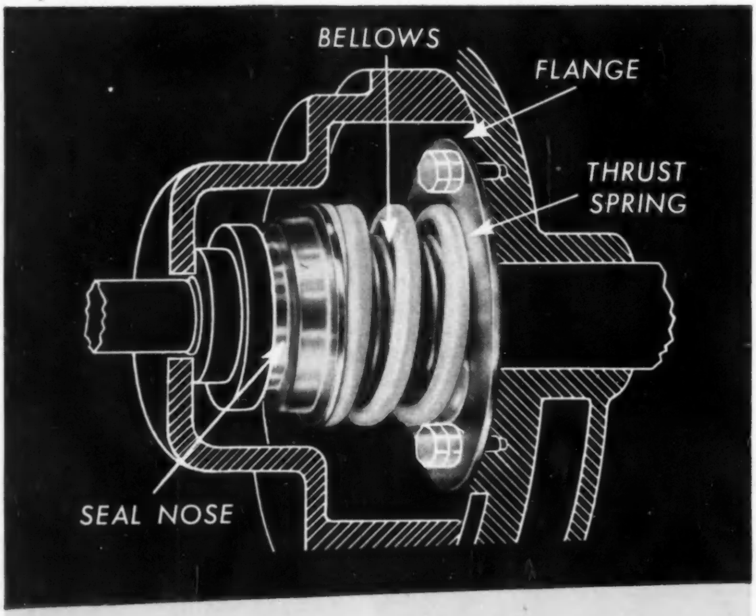
Outside Section Territory

Richard S. Cook, Jr. (J), John C. Curtiss (M), Clair G. Dibert (M), Charles R. Johnson (M), Donald G. Parker (M), Robert W. Petersen (A), William L. Stultz, Jr. (M), George C. Vaughan (M).

Foreign

Leonard C. Dempster (M), Bermuda; Dr. Rudolf O. Hoss (M), West Germany; Zvi Gregory Levinson (M), Israel; Horacio Shakespear (M), Argentina.


Since 1912...
CLEVELAND
Universal Joints
Propeller Shafts and
Power Take-Off Joints
Now...in 1956...
The only propeller shaft with a
32 TOOTH CONVENTIONAL
SPLINE SHAFT!
✓For much greater strength without increasing diameter.
✓Better precision-fit between mating pieces.
✓Better sliding action (between shaft and spline yoke) under torque conditions.
Cleveland Steel Products Corporation
Automotive Division
16025 Brookpark Road • Cleveland 11, Ohio



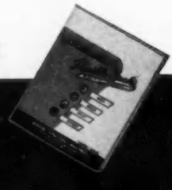
HOW TO LEAKPROOF SHAFTS AT HIGH TEMPERATURES

It makes no difference whether you expose them to a -100°F. deep freeze or a singeing 600°F. Fulton Sylphon rotary bellows seals will still leakproof rotating shafts against corrosive, explosive or contaminating fluids and gases.

One reason is that this seal features a seamless, flexible metal bellows which expands, contracts and deflects to apply the proper sealing pressure at all times. Furthermore, the Fulton Sylphon bellows seal is made with silver solder for extra high-temperature protection.

You can obtain Fulton Sylphon bellows seals in rotating or stationary types for pressures up to hundreds of pounds and shaft speeds up to 20,000 RPM. For the atomic energy and other industries, they're also available with welded construction to solve special contamination problems.

SEND FOR BULLETIN 827-PE



V-FACE SEALS

Formerly called flat seals, Fulton Sylphon V-FACE Seals assure leakproof sealing of flat surfaces at temperatures from -100°F. to 800°F. and at pressures up to 5,000 psi.

Robertshaw-Fulton
Mr Controls
CONTROLS COMPANY
FULTON SYLPHON DIVISION · Knoxville 1, Tenn.

Applications Received

The applications for membership received between June 10, 1956 and July 10, 1956 are listed below.

Atlanta Section
Leon E. Baughman.

Baltimore Section
Richard J. Kenny, G. T. Willey.

Buffalo Section
Robert K. Hathaway.

Canadian Section
William Bahrych, Philip T. Briard, Robert W. Purcell.

Central Illinois Section
Arthur O. Beer, Jack L. Langenberg, Clayton C. Smith, Joseph J. Wochner.

Chicago Section
Leonard S. Burns, Raymond H. Collins, Theo Davis, Jr., William F. Dawson, G. Forrest Drake, Mack M. Jones, Victor E. Rimsha, Fred P. Robinson, Bert M. Walter.

Cleveland Section
Don E. Ehrlich, Sanford Jaffe, James E. Macholl, H. Allen Nitshke, Raymond J. Salehar, Samuel L. Spooner, Jr., Foster J. Young.

Colorado Group
James R. Mondt, Ernest L. Teller.

Dayton Section
John R. Tibbitts.

Detroit Section
John Belavich, Donald W. Bullock, Louis V. Cachat, Dale K. Cole, Marcus G. "Mickey" Golden, Howard E. Hermenau, Daniel W. Hoffman, William A. Hunko, John L. King, Jerome B. Koch, Gerald M. Larson, James J. MacKay, Ralph W. McCort, Ralph L. McGovern, Joseph H. McIntyre, Jerome F. Meek, Peter N. Pentescu, James J. Schultz, Jr., George G. Spehn, Richard L. Vroman, Leo E. Warren, Edmund Wieczkowski, Douglas J. Wing, Leonard J. Zukowski.

Hawaii Section
J. Lowell Twidwell.

Indiana Section
George R. Anderson, John E. Buskirk, Donald E. Schmidt, Edward C. Van Buskirk.

Applications Received

Continued

Kansas City Section

Dale P. Wire.

Metropolitan Section

Jack Cascio, William K. Detweiler, Thomas V. Fitzgerald, Richard L. Kline, Raymond C. Kropp, Daniel S. Maisel, Joseph Pohrebnoy, A. Milford Pope, Stuart B. Rote, Jr., H. Joseph Schineller, Arthur B. Stanley, Frederick W. Thul.

Mid-Michigan Section

Reigh C. Gunderson.

Milwaukee Section

Irving R. Christensen, Herbert F. Haubrich.

Montreal Section

Charles P. Kirwan.

New England Section

Robert B. Clark, George Sorkin.

Northern California Section

Robert C. Cuffel, Richard L. Reiley. Herbert M. Schick, Robert K. Stone.

Northwest Section

Joseph D. Weatherstone.

Philadelphia Section

Frank Breckenridge, Charles B. Hood, Jr., Hilding R. Hultkrans, Arthur A. Kelly, Jr., W. A. Pavlo, Robert S. Potteiger, John Romanchick, George F. Sharrard, William H. Unger.

Pittsburgh Section

S. Allen Oviatt, W. W. Wentz.

Southern California Section

George F. Anisman, Earl J. Beck, Jr., George W. Brooks, Martin L. Close, Robert Emerzian, Don W. Geri, Robert B. Glassco, Nyle O. Movick.

Southern New England Section

Jerome Belsky, Norman Gordon, J. Leo Raesler, John A. Rinek, W. Robert Spencer.

Syracuse Section

D. Henry Edel, Jr., Donald B. Jones.

Texas Section

Robert E. Lutz.

Texas Gulf Coast Section

Andrew J. Freund.

Washington Section

Lt. Col. Sir Frederick G. L. Coates.

Western Michigan Section

J. C. Owen.

Williamsport Group

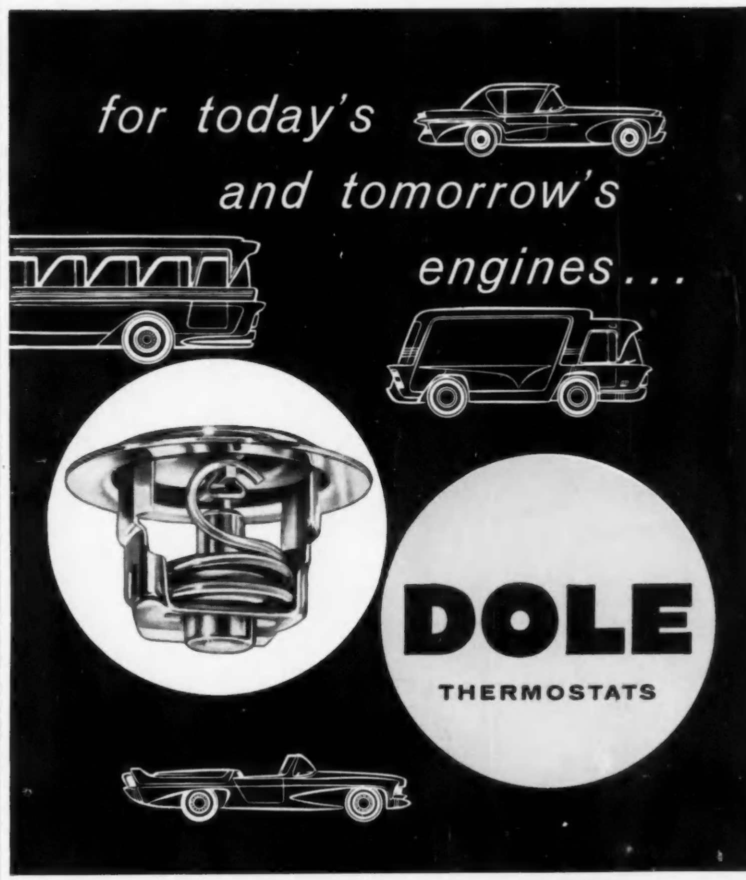
Norman A. Allan.

Outside of Section Territory

Wade Allen, Roger M. Atherton, Jr., William G. Biederman, Harold E. Fuerst, Thomas W. Hubbell, Allen D. Lodge, Leo C. Peters, John W. Richard, Jr., Earle D. Van Leeuwe, John R. Wright.

Foreign

Anthony P. Drayton, Puerto Rico; Yoshito Matsuo, Japan; Zoltan Pazmany, Argentina; Niels E. Sorensen Viale, Argentina; David L. Spanjer, England.



these are the reasons why Dole Thermostats are standard equipment on 37 of the leading makes of cars, trucks, tractors, commercial vehicles, industrial and marine engines.

- Positive operation against increased pump pressures
- Good service with all types of antifreeze solutions
- Help maintain best engine performance
- Speed warm-up and get more heat from the car heater.

Write for information.

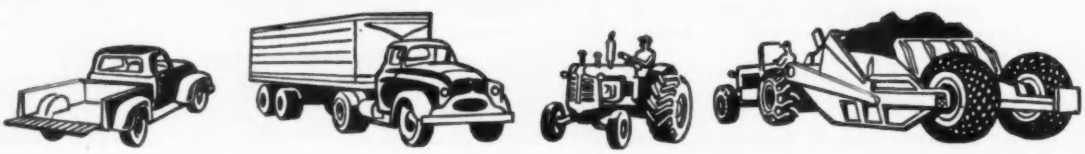
Control with DOLE 1906 1956 50th Anniversary

THE DOLE VALVE COMPANY
1901 Carroll Avenue
Chicago 12, Illinois

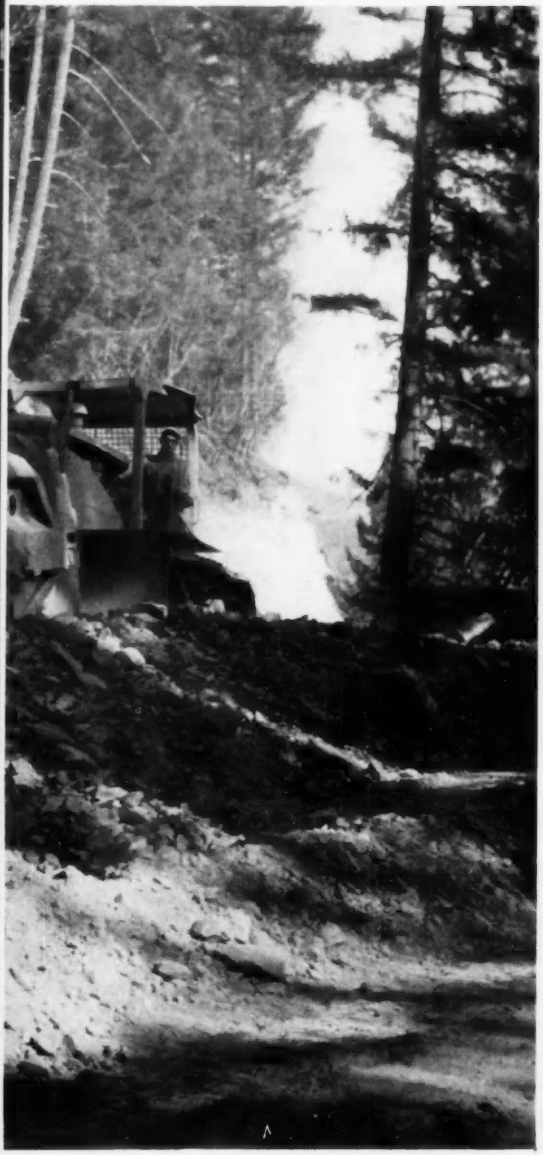
Control with
DOLE
(TRADE-MARK)
Detroit Los Angeles Philadelphia

The rim that on the world's

New Tru-Seal Rims—for sizes 12:00 and up, including all earth-mover and grader sizes. This rim is similar to multiple-piece rims now in use—PLUS airtight Tru-Seal rubber ring which compresses into locking groove when tire is mounted.



put tubeless tires toughest jobs



WE DON'T have to tell you what an advantage tubeless tires are in grinding, grueling off-the-road operations. You're looking at the rim that has made this possible: Goodyear's remarkable new Tru-Seal Rim.

This notable rim development embodies the famous Tru-Seal principle (shown in diagram)—the only workable and economical method ever devised to seal a multiple-piece rim. This permits the practical use of tubeless tires on all vehicles using size 12:00 or larger tires.

Yet Tru-Seal is just one of the many advances stemming from Goodyear's long years of leadership in rim construction. With Goodyear Rims you get:

Unusual Strength: Thanks to an exclusive double-welding process, and added support at points of greatest stress, present day Goodyear Rims are far stronger than previous rims.

Ease of Tire Mounting: No tube and flap troubles.

Special Tools: Goodyear alone provides both hydraulic and hand tools especially made for off-the-road equipment.

Bond-a-Coat Finish – This protective coating affords long-lasting resistance to rust and corrosion.

What's *your* rim problem?

Result of these Goodyear-pioneered rim improvements is the virtual elimination of down time due to rim failure. Why not profit by these advantages when solving your rim problems? The G.R.E. (Goodyear Rim Engineer) will help you select the type and size of rim best suited to your needs. Write him at Goodyear, Metal Products Division, Akron 16, Ohio, or contact your local Goodyear Rim Distributor.

Buy and Specify

GOODYEAR

Tru-Seal—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio

MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND


Spicer has supplied
for a wide range of
Your need + Dana
skill and engineering = the right
axle for the job!
SELF-PROPELLED FARM IMPLEMENT
LIFT TRUCK
FIRE FIGHTER
SPORTS CAR
GOLF CART
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LIGHT TRUCK
POWER SWEEPER
A FEW TYPICAL
SPICER-BUILT AXLES . . .
and a few of the many different types
of vehicles in which they are being used.
DANA CORPORATION · Toledo 1, Ohio

MILLIONS OF AXLES

Power Driving Needs!

Spicer has over 50 years of power-transmission experience . . . has the most diversified corps of engineers in the industry . . . and has the industry's largest group of production facilities.

Spicer can design and manufacture axles for ANY type of light- and medium-duty motor-driven vehicle you produce!

Spicer experience includes a wide range of axles for units such as:

- Light and Medium Duty Trucks
- Passenger Cars
- Road Markers
- Power Sweepers
- Golf Carts
- Motor Scooters
- 4-Wheel Drive Trucks
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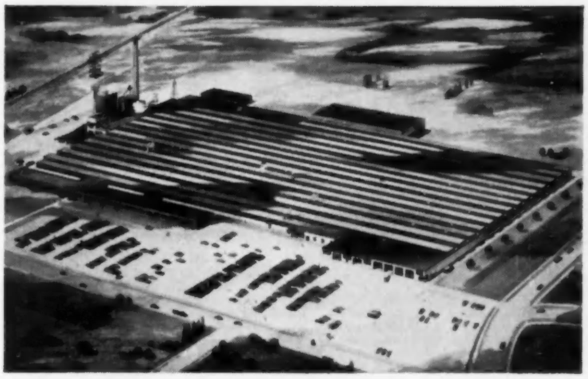
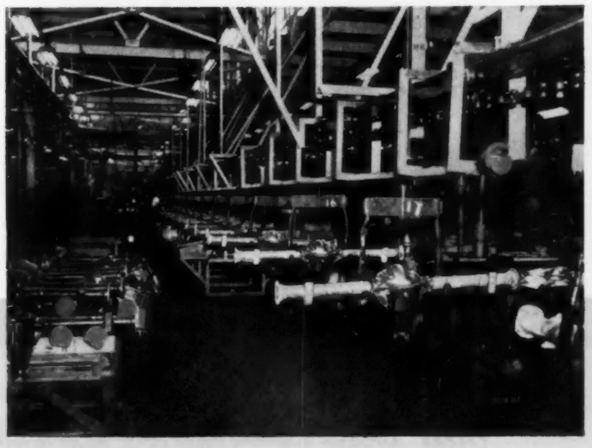
and many other specialized types of vehicles.

Write for Spicer Axle Engineering Bulletin No. 364, and ask for an engineering conference on your particular axle requirements. We can supply your needs—*quickly and efficiently!*



600,000 sq. ft. of production facilities at Fort Wayne Axle Division . . . one of the 10 modern plants operated by the Dana Corporation.

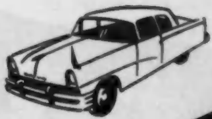


The Fort Wayne Axle Division is equipped with the most modern and efficient production systems, capable of producing thousands of axles daily.

ALSO CASES, SHAFTS AND GEARS

FOUR WHEEL DRIVE TRUCK

ROAD MARKER

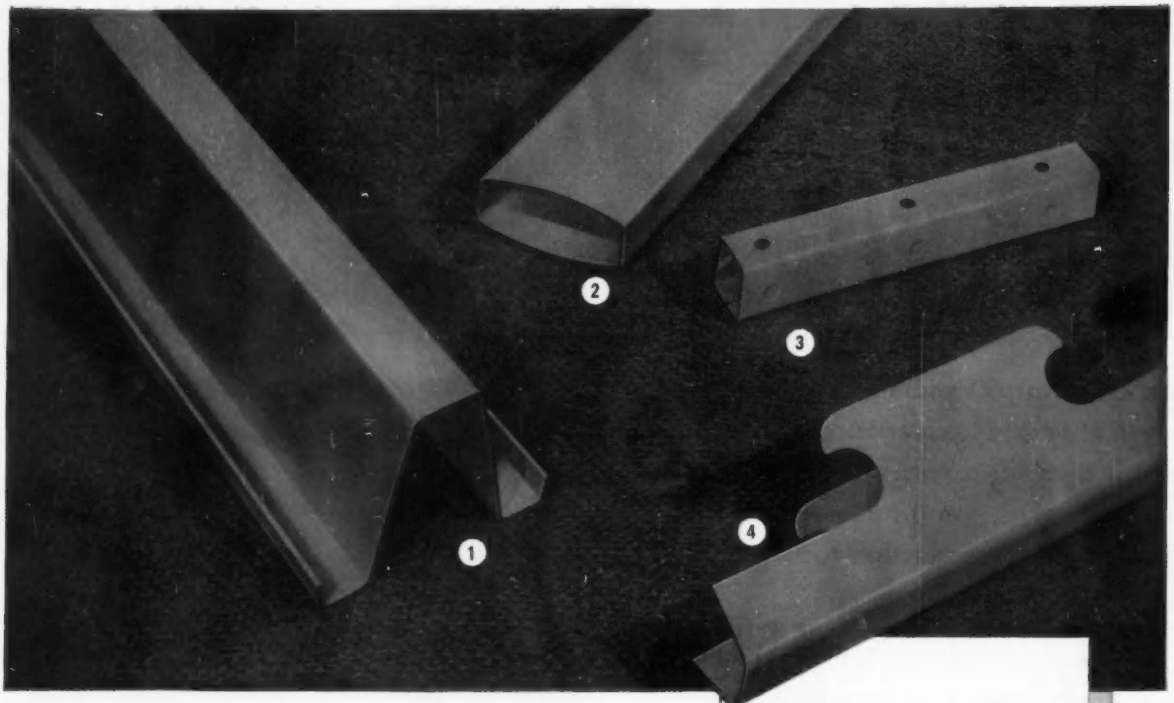


PASSENGER CAR

Spicer

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES • SPICER FRAMES

AXLES ALSO MANUFACTURED IN CANADA BY HAYES STEEL PRODUCTS LIMITED, MERRITTON, ONTARIO



HAT SECTION roll formed without cracking painted surface. No scratching despite considerable wiping action of multi-diametered rolls.

BOTTOM RAIL FOR VENETIAN BLIND. Unusual flexibility of finish permits roll forming and double lock seaming without breaking painted surface.

KNEE BRACE STRUCTURAL COMPONENT scored for knockouts, then formed to rectangular section without lifting finish. Knockout plugs practically invisible in pre-painted material.

STRINGER blanked from pre-painted strip. Paint adheres tightly to extreme edges. No flaking or lifting to mar finish.

These EXTRA properties make tough forming jobs easy!

HUNTER-DOUGLAS *Pre-painted* ALUMINUM STRIP

Mill quantities available in several aluminum alloys and tempers; wide color range.

UNUSUAL FORMABILITY—Hunter-Douglas coatings are specially compounded for high flexibility, freedom from cracking, chipping or peeling. The pre-painted strip readily roll forms, embosses, stamps... surface coating even stretches sufficiently to permit *deep drawing* without damage.

GOOD EXTERIOR DURABILITY—Finishes are remarkably colorfast in sunlight, resistant to heat and cold and successfully pass 500 hour, 90°, 20% salt spray test with no sign of lifting or blistering.

DOUBLE COATING, with each coat baked, produces a hard, bright, and completely opaque finish with excellent adhesion and resistance to scratching.

COLORS—Available in a wide range of decorative colors with excellent color reproduction.

WIDTHS—Up to 8" maximum and in nominal thicknesses.

For applications subject to severe weather exposure or exceptional forming stresses, for unusual beauty without need for subsequent painting specify Hunter-Douglas Pre-Painted Aluminum Strip... costs a little more, saves a lot!

Hunter Douglas HD Aluminum Corporation

HUNTER-DOUGLAS ALUMINUM CORPORATION, DEPT SA-8 • RIVERSIDE, CALIFORNIA • TELEPHONE OVerland 3-3030

Combat commuter –

at 8 second intervals

In recent tests duplicating actual assault landings, Fairchild C-123's gave dramatic evidence of performance under combat conditions.

The target – a rough, ungraded field – was ringed by "hostile" forces. Heavily laden, the C-123's approached the field at 500 ft. altitude – too low for heavy A.A. guns, too high for small-arms fire. Just short of their touchdown point, the highly maneuverable assault transports swept down, flaring out just as they flashed over the clearing's edge. Two minutes later, twelve C-123's had rolled to a halt – troops and trucks were fanning out to their assigned positions. The C-123's had landed at *8 second intervals!*

This dramatic demonstration of pilot and crew proficiency was made possible by C-123 maneuverability, short field performance and utter reliability – all three, features of Fairchild aircraft designs.

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AIRCRAFT DIVISION • HAGERSTOWN 10, MARYLAND

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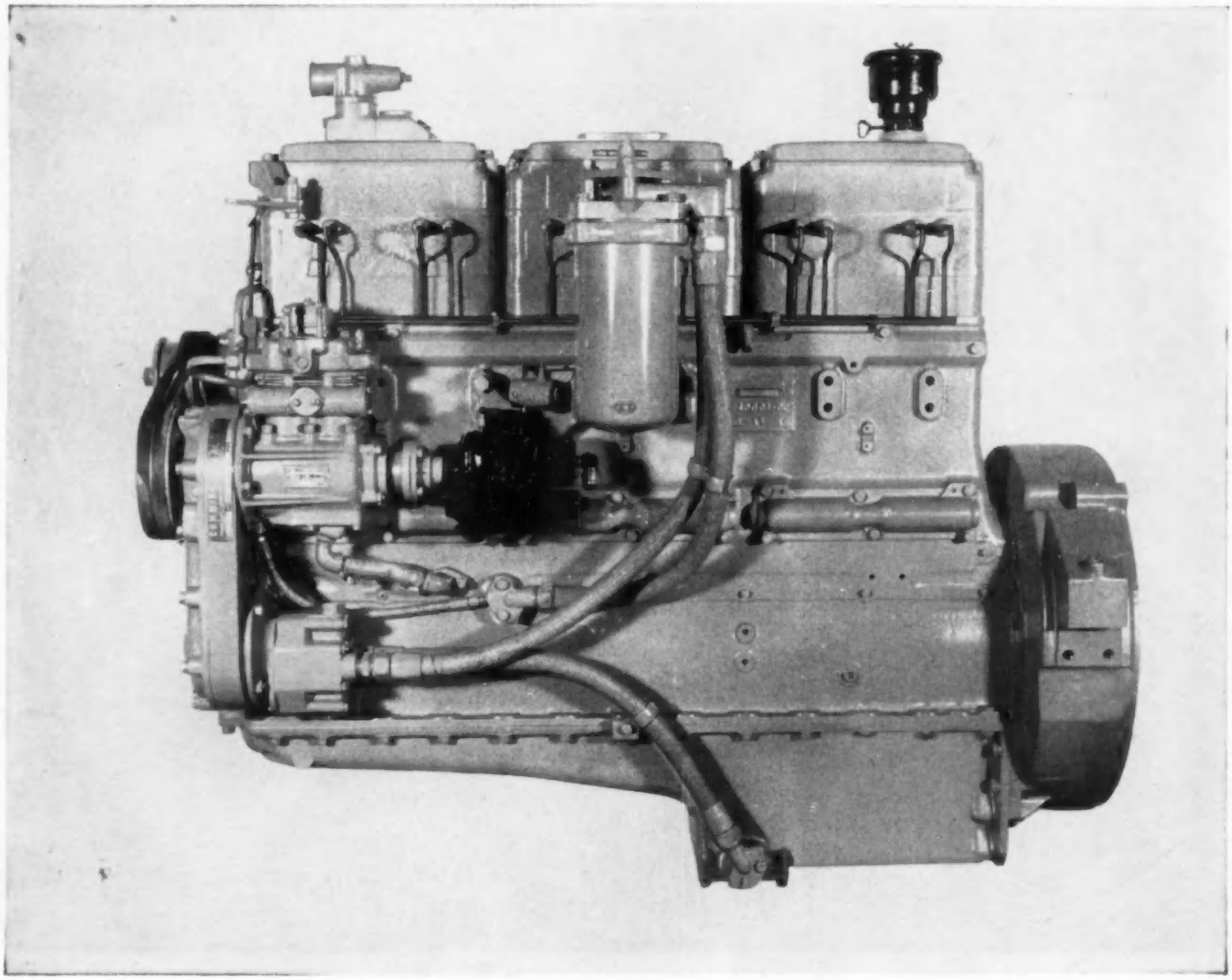
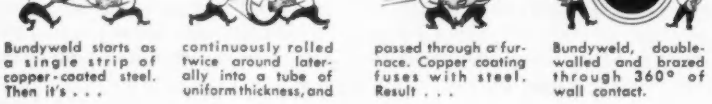
...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

Moving an iron mountain, rely on lifelines



Powerful, rugged Cummins Diesel model HRB-600 is one of a complete line of Cummins diesels ranging from 60 to 600 hp. Bundyweld Steel Tubing fuel injector lines, indicated here in natural copper, provide leakproof performance, withstand vibration in all kinds of service.

BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP



Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

←

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

Cummins Diesels of Bundyweld Tubing

These 30-cubic-yard Mack trucks are part of a fleet of 24 that haul 5,000,000 long tons of ore a year from Cerro Bolivar, Venezuela's mountain of iron. Cummins Diesels, used by the entire fleet, rely on vital fuel lifelines of Bundyweld Steel Tubing.

Another example of the way double-walled Bundyweld steel tubing provides leakproof, dependable performance in the most difficult applications

Cummins Engine Company, Inc., of Columbus, Indiana, world's leading independent producer of high-speed, light-weight diesels, is known the world over for engines of rugged durability. To protect this reputation, Cummins specifies Bundyweld Steel Tubing for vital fuel lifelines.

Manufacturers like Cummins choose Bundyweld because it is the only steel tubing that is double-walled from a single metal strip, copper-bonded through 360° of double-walled contact. They know too, that Bundyweld Tubing is leakproof; thinner-walled, yet stronger; has high bursting strength; and is remarkably resistant to vibration fatigue.

But high quality is only one of the big advantages you get with Bundyweld Tubing. Others are: expert engineering service, modern fabrication facilities, and prompt, on-schedule deliveries. For more information write, wire, or phone us, today!

BUNDY TUBING COMPANY, DETROIT 14, MICHIGAN

BUNDYWELD® TUBING

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Pictured below are four reasons why Rohr is world-famous as the builder of ready-to-install Pow-R-Pax for airplanes. In addition to the Lockheed Super G Constellation—Rohr builds the Pow-R-Pax for many other leading commercial and military planes including the Boeing KC-135, B-52, Douglas DC-7 and the Convair 440.

PLUS OVER 30,000 OTHER DIFFERENT AIRCRAFT PARTS. Currently, Rohr is producing over 30,000 different parts for aircraft of all kinds—utilizing the vast design, engineering and production experience gained from building thousands upon thousands of power packages . . . far more than anyone else in the world.

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POW-R-PAX FOR AIRPLANES

ROHR
AIRCRAFT CORPORATION

Chula Vista and Riverside, California

On materials handling machines used by


Hyster


Baker - Raulang

modern farmers ... by the armed forces ...


Prime Mover


Gerlinger

and by all branches of industry ...

Towmotor

BLOOD BROTHERS UNIVERSAL JOINTS

are first choice!

On all kinds of materials handling equipment, dependable Blood Brothers Universals have won "first choice" reputations. This success results in part from close cooperation between our engineers and the men who design the machines . . . with the mutual goal of superior performance for the end user.

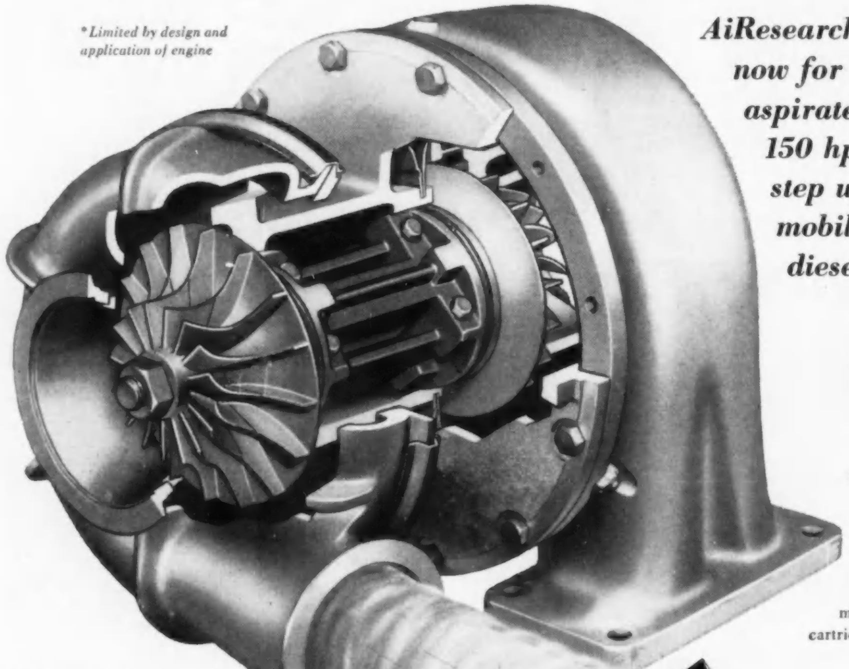
When you have a power transmission problem — large or small — contact Blood Brothers' engineers for suggestions. They'll gladly work with you . . . just write or call.

BLOOD BROTHERS
MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

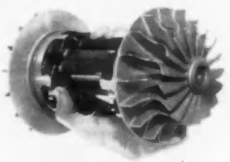
UNIVERSAL JOINTS
AND DRIVE LINE
ASSEMBLIES

AiResearch Turbochargers improve diesel engine performance up to 100%*

*Limited by design and application of engine



AiResearch units are available now for use with normally aspirated diesel engines of 150 hp and up. They step up performance of both mobile and stationary diesels, land or marine.



Removable cartridge simplifies repair and overhaul

This cartridge contains the turbocharger's rotating assembly, bearings and seals in a factory balanced package. It can be replaced in minutes with another factory balanced cartridge by a mechanic on the scene.

AiResearch has more experience in the design and manufacture of small turbomachinery than any other company. AiResearch turbochargers are the most efficient and safest units of their kind. New additions to the AiResearch family of turbochargers have widened their range of application in the diesel engine industry.

Our engineers welcome the opportunity to work with you in improving the performance of your diesel engines. We are happy to confer on applications of the turbocharger principle to your power plants.

AIRESEARCH TURBOCHARGERS NOW AVAILABLE

MODEL	T-10	T-15	T-16	T-30
Diameter — in. nom.	9	15¼	11½	15¼
Length — in.	9	16¾	15¾	17¼
Weight — lb.	39	125	100	135
Output — lb/min. (Standard Conditions)	25-40	35-65	45-65	70-95

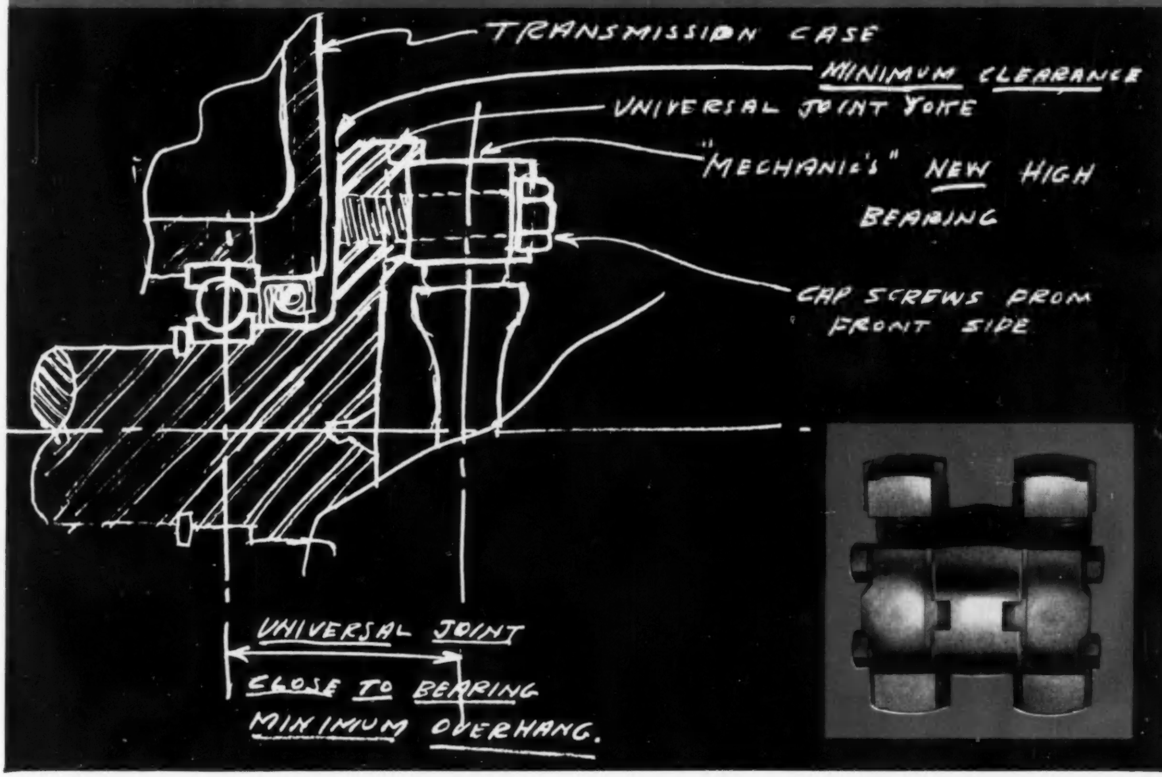
THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND RELATED MACHINERY

SOLVE YOUR CLEARANCE PROBLEM THIS WAY



If you are faced with the problem of locating a universal joint in a space where limited clearance does not permit the use of a flanged joint, MECHANICS close-coupled Roller Bearing UNIVERSAL JOINT is your solution. This joint is specially designed for operation within cramped quarters that engineers formerly considered too short to accommodate a universal joint. Let our engineers show you how MECHANICS close-coupled UNIVERSAL JOINTS will conserve space, compensate for offset shafts and provide ample angularity in your new, compact models.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2022 Harrison Ave., Rockford, Ill.
Export Sales: Borg-Warner International
36 So. Wabash, Chicago 3, Illinois

MECHANICS
Roller Bearing
UNIVERSAL JOINTS

BW

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

The turnabout that made possible a new tool

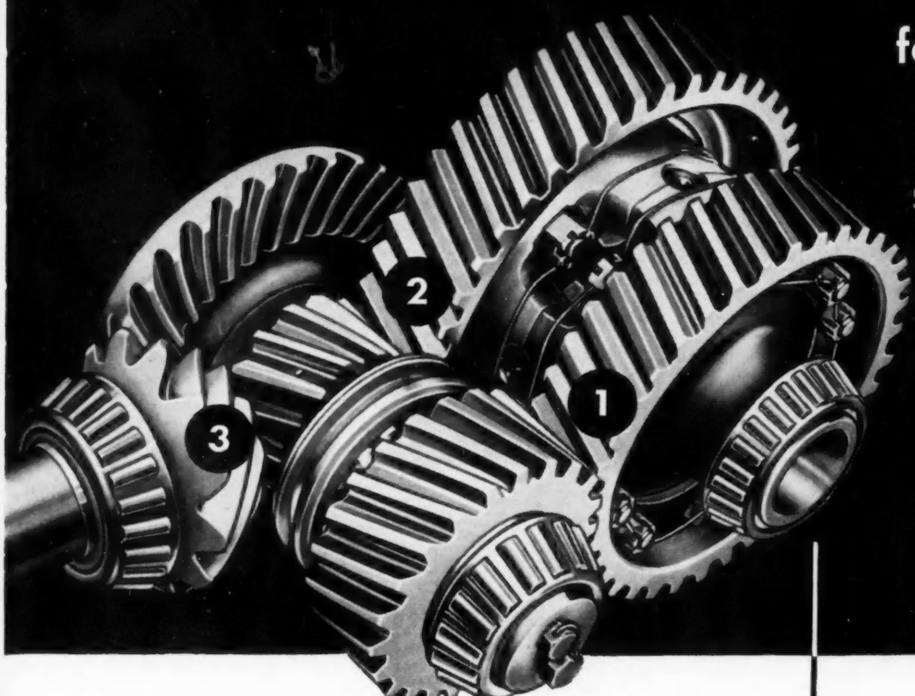
the new TDA®

WIDE RANGE®

2-speed axle

A new member of the famous TDA 2-speed axle family

for application of automotive power...



for operations requiring short transmission steps and high over-all gear reduction

The new TDA WIDE RANGE 2-Speed Axle (available in both 2 to 1 and 2½ to 1 ratio spreads) offers all the highly desirable advantages heretofore available only through the use of complex multiple-speed transmissions or auxiliary gear boxes, without many of the penalties of either one or the other:

WITHOUT laborious two-stick shifting.
WITHOUT wasteful excessive weight.
WITHOUT increased driver fatigue.
WITHOUT unusual wheelbase limitations.
WITHOUT higher initial vehicle cost.
WITHOUT higher maintenance cost.
WITHOUT excessive wear on the lower speed gears of the transmission.
WITHOUT restricted over-all gear reduction.
WITHOUT complicated shift patterns.

For complete information on the new TDA WIDE RANGE Axles now available, call, wire or write your nearest vehicle dealer or branch.

WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSES AND TRAILERS

Here's the simple switch that turned the trick!

The broader range of the new Timken-Detroit® WIDE RANGE 2-Speed Axle was achieved by a fairly simple mechanical rearrangement. We "flipped" our high-range (1) and low-range (2) helical gear sets—reversed their relative positions—to place the enlarged helical pinion of the high-range gear set where it would not interfere with the hypoid pinion (3) of the first-reduction gear set.

Plants at: Detroit, Michigan • Oshkosh, Wisconsin Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

©1956, R S & A Company

TIMKEN *Detroit* AXLES

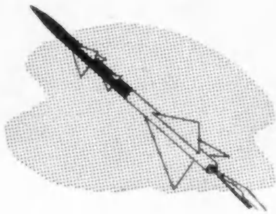
TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

Accepted Standard
TRADE MARK REGISTERED

Engineers............

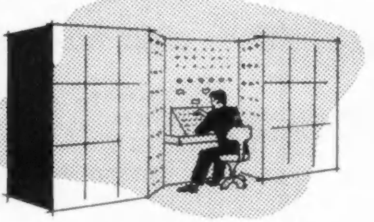
You are Invited to join the permanent staff of the Electronics Division of General Motors Corporation where you will be given every possible advantage for personal development.

THE ELECTRONICS DIVISION OF GENERAL MOTORS CORPORATION



CHALLENGING OPPORTUNITIES

in the following fields: Avionics, Missile Guidance Systems; Jet and Turbo Prop Engine Controls; Bombing Navigational Computer Systems; Airborne Fire Control; and U.H.F.-V.H.F. Communications.

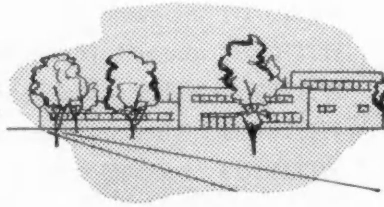


FINEST RESEARCH FACILITIES

The best possible test and development equipment available to you. You will enjoy working with the top men in the field under the most favorable conditions.

GENERAL MOTORS POLICY

GM has for years been an outstanding leader in terms of products and personnel benefits. GM's long-standing policy of decentralization creates individual opportunity and recognition. Investigate for your own future. Write today in fullest confidence for Enrollment Application to Mr. John F. Heffinger, Supervisor of Salaried Personnel.

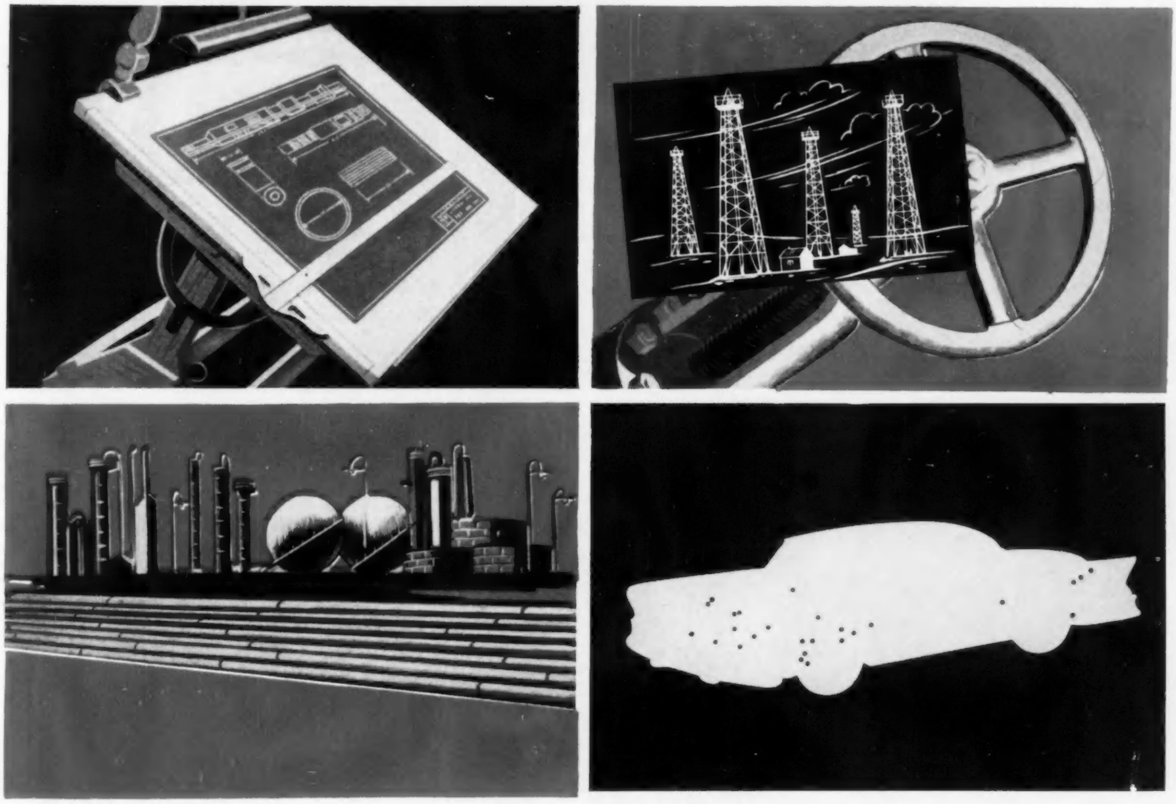


AC SPARK PLUG — THE ELECTRONICS DIVISION

GENERAL MOTORS CORPORATION

MILWAUKEE 2, WIS. — FLINT 2, MICH.

Naugatuck Paracrils



...oil-resistant rubbers for all critical applications

In every industry, Naugatuck's family of superior oil-resistant rubbers is bound to bring longer service life under the most critical conditions. Graded to provide specific property values, the family of PARACRILS® provides:

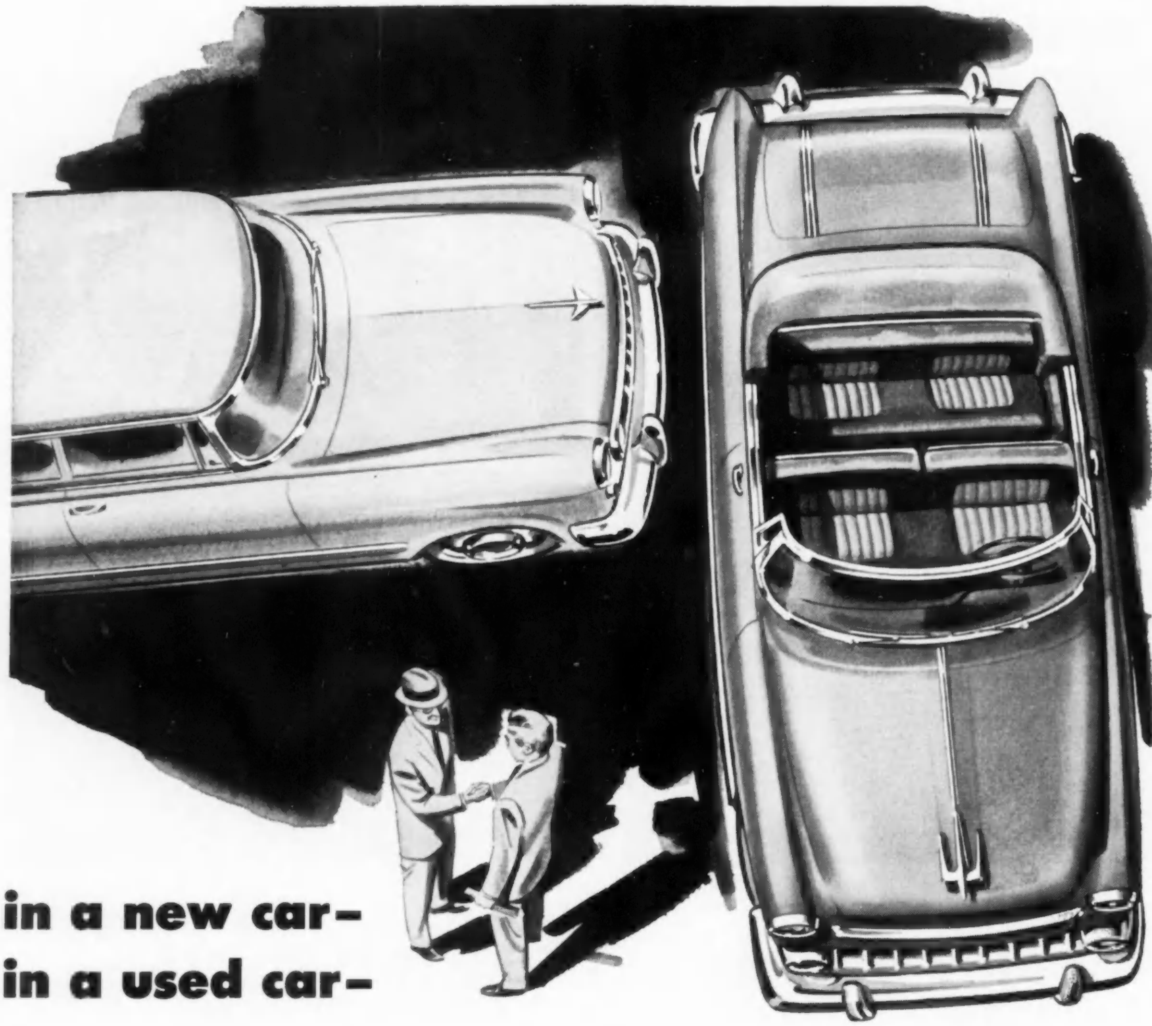
- The most oil-resistant rubber available
- The best balance between oil-resistance and low-temperature flexibility.
- The best processing characteristics
- The most tightly-controlled product specifications
- Excellent resistance to aging at elevated temperatures
- High abrasion resistance
- The best resistance to air and gas permeability

If your rubber or rubber-like products require high oil resistance it will profit you to investigate Naugatuck's PARACRILS Why not write to us on your company letterhead TODAY?

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

IN CANADA: NAUGATUCK CHEMICALS, Elmira, Ontario • Cable Address: Rubexport, N.Y.
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices



in a new car—
in a used car—

Stainless Steel sells and re-sells!

The Stainless Steel trim, molding and vital parts that add style and beauty to a car, inside and out, are features that help make the sale.

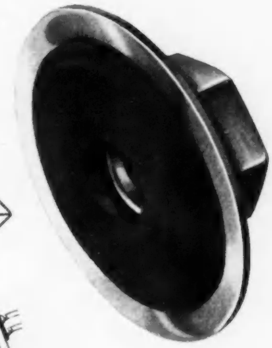
Stainless Steel has wide customer acceptance. It's easy to clean and keep clean. It's a tough, solid metal that will not corrode or dent and stands up to gravel, ice, salt and water.

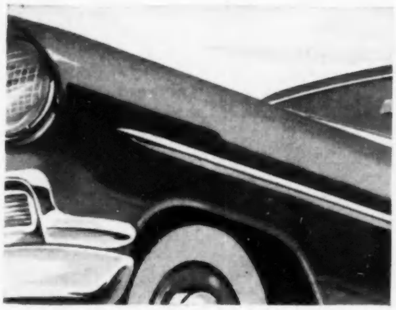
The finish never fades and parts are easy to replace. Stainless Steel lasts the life of the car. It *sells* in a new car and it *re-sells* in a used car.

McLOUTH STAINLESS STEEL for automobiles

McLOUTH STEEL CORPORATION, *Detroit, Michigan, Manufacturers of Stainless and Carbon Steels*

A nut, washer and sealing gasket ALL IN ONE!





DAREX *Flowed-in* GASKETS

are streamlining traditional methods of attaching chrome trim to automobiles.

Contrasted with the laboriously slow method of hand assembling gasket to trim fastener, the DAREX method automatically *pre*-gaskets the part by machine. So that now a single fastener — applied in a single operation — *fastens* the trim and *seals* the hole against seepage of dirt and moisture.

The DAREX "Flowed-in" Process is ingeniously simple. A DAREX gasketing compound is *machine-flowed* directly onto the fastener. This "flowed-in" compound is then cured to form a solid, rubbery gasket which becomes *integral* with the part. With nut, washer and gasket all in one unit, automobile manufacturers find assembly-line fastening of chrome trim much easier and quicker. And the finished job is neater, better, less costly than before!

If you have a problem involving a gasket, cushion, seal or vibration dampener, tell us about it. Perhaps the DAREX "Flowed-in" Process can help you increase production or quality of your product . . . and at the same time lower your labor and materials costs.

"H637 COMPOUND"

One of several standard DAREX "Flowed-in" compounds now being used by the automotive industry.

Base: Vinyl

Adhesion to metal: Excellent, no primer coat needed

Torque retention: Excellent

Staining: No migration staining

Temperature resistance: -20° to 250°F.

Aging: Excellent

Consistency: (Wet) Non-slumping paste (Dry) Rubbery solid

Curing time: 20 seconds

Uses: As a weather seal against water, dust and dirt

DESIGNED FOR THE AUTOMOTIVE INDUSTRY

The new DAREX No. 6 Compound Applying and Curing Machine applies and cures gaskets automatically at high speeds (up to 200 per minute on trim fasteners shown above.) Occupies only 17 sq. ft. of floor space. Write Dewey and Almy Chemical Company, Cambridge 40, Massachusetts for further information today.

DA

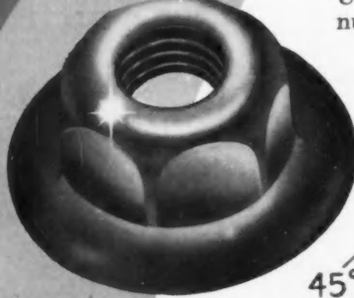
DEWEY AND ALMY
CHEMICAL COMPANY
DIVISION OF W. R. GRACE & CO.

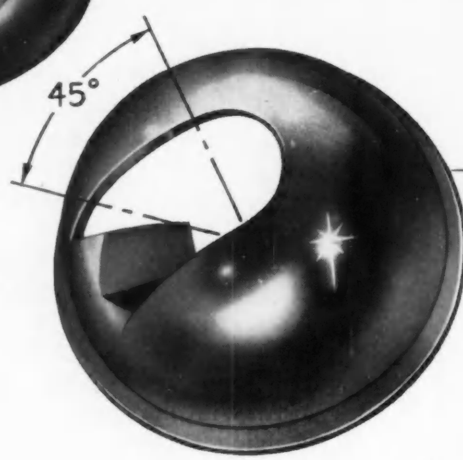
DOT's new angle washer holds cast trim against curves

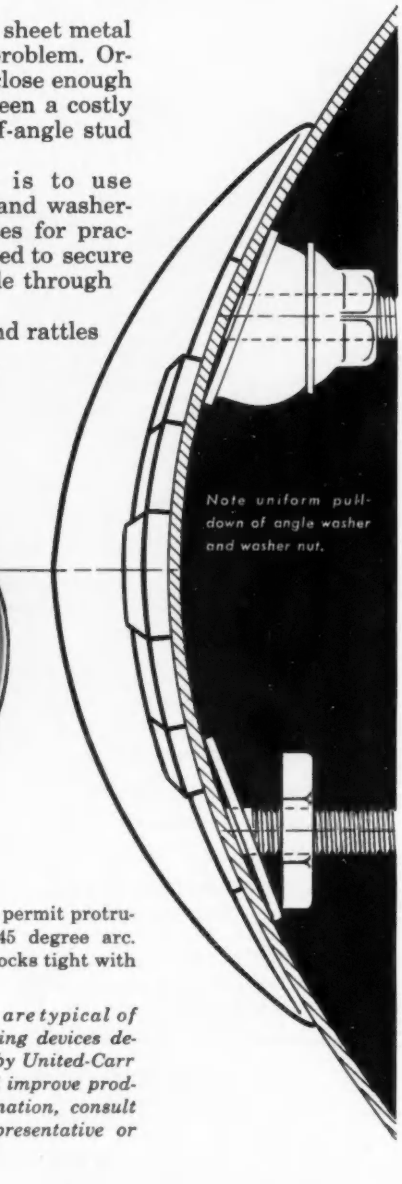
Fastening die-cast trim to curved sheet metal surfaces can be a troublesome problem. Ordinary nuts jam before they get close enough to hold tight. One solution has been a costly mould construction permitting off-angle stud casting.

The modern cost saving way is to use United-Carr's new angle washer and washer-nut combination. This compensates for practically any curve or can be used to secure studs that protrude at an angle through a flat surface.

Tight fastening is assured and rattles never get a chance to start.







Light, strong metal shell is slotted to permit protrusion of stud at any angle within 45 degree arc. Washer nut matches shape of shell, locks tight with normal wrench torque.

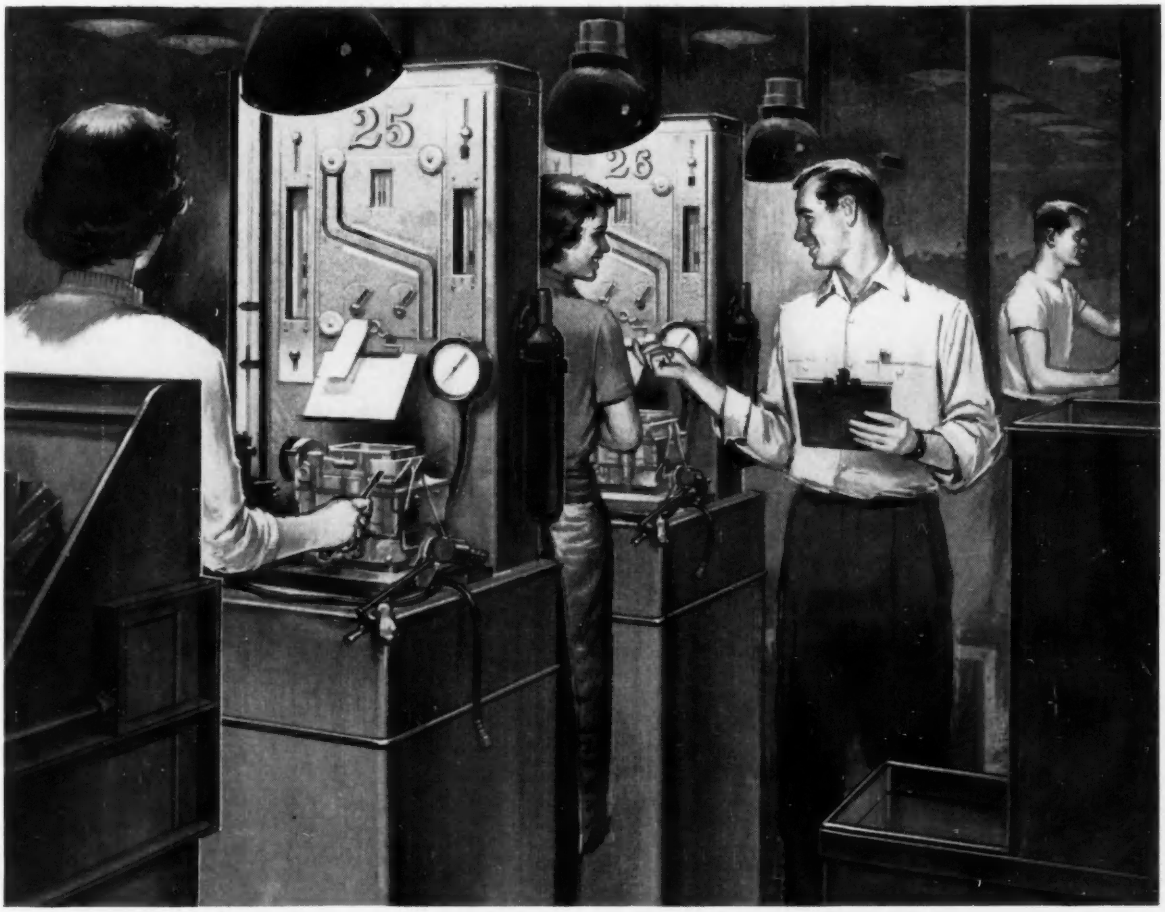
The angle washer and washer nut are typical of thousands of special-purpose fastening devices designed and manufactured in volume by United-Carr to help speed assembly, cut costs and improve product performance. For further information, consult your nearest United-Carr field representative or write us for his name and address.

UNITED-CARR Fastener Corp.

31 Ames Street, Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

AT CARTER . . .



The Fuel Must Flow

In this busy flow-test room every Carter carbureter is thoroughly tested prior to shipment. Each unit, under various degrees of vacuum, must deliver a specific amount of fuel. Fuel flow must be held to close tolerances to meet the requirements of the engines for which Carter carbureters are designed.

This highly realistic flow-testing operation is just one of many ways in which Carter controls quality. The results are apparent in the dependable, trouble-free performance of Carter fuel system products on millions of cars on the road today.

CARTER CARBURETOR

DIVISION OF acf INDUSTRIES INCORPORATED • ST. LOUIS 7, MISSOURI

JACK COLE *cuts trip time 20%*

. . . with FULLER Semi-automatic ROADRANGER® Transmissions

It's now 24 hours instead of 30 from Birmingham to New York and 26 instead of 32 hours from Birmingham to Philadelphia. Jack Cole Company's new fleet of 43 GMC 860 diesel tractors equipped with Fuller 10-speed semi-automatic R-96 ROADRANGER Transmissions have cut 6 hours off each trip.

Says Jack Cole, President of Jack Cole Company, Birmingham, Alabama: "Our Fleet Supervisor, O. B. Johns, Jr., insisted on the ROADRANGER Transmission for the new tractor to get the ability needed for faster trip time."

Fuller ROADRANGERS provide extra *ability* with:

- **Easier, quicker shifts—10 forward speeds with short 28% steps between ratios**
- **One shift lever that controls all 10 forward speeds**
- **No gear splitting — 10 selective gear ratios evenly and progressively spaced**
- **Higher average road speeds — engines operate in peak hp range with greater fuel economy**
- **Less driver fatigue—1/3 less shifting**
- **Range shifts pre-selected — automatic and synchronized**
- **Space-and-weight-saving economies — the most compact 10-speed transmission available**
- **Transmission weight under the cab—permitting more cargo to be carried on the payload axles**

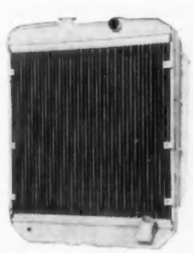
To shorten trip time—to cut maintenance costs—to give *your* drivers complete control of every driving condition, specify Fuller semi-automatic ROADRANGER Transmissions.

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

KO's heat for the heavyweight champ!

Harrison Handles Heavy-Duty Heat Job for Chevrolet Task-Force Trucks!



Harrison knocks heat cold for Chevrolet! The task-force fleet depends on Harrison heavy-duty, high-capacity radiators to cool the engines. For frequent short hops or long, rugged hauls, you can't beat Harrison for beating the heat. That's because Harrison has the experience, engineering skill and extensive research facilities to keep pace with the ever-increasing demands of modern high-speed carriers. If you have a cooling problem, look to Harrison for the answer!

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

GM GENERAL MOTORS

TEMPERATURES MADE TO ORDER

HARRISON

NEW

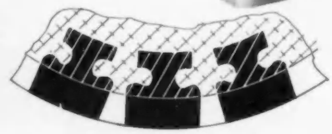
ESPECIALLY DESIGNED FOR TOP RING GROOVE PROTECTION IN PISTONS FOR GASOLINE ENGINES

AN ECONOMICAL METHOD WITH MINIMUM WEIGHT INCREASE

CAN BE APPLIED TO ANY TYPE ALUMINUM ALLOY PISTON

PERMA-GROOVE*

WITH SEGMENTAL STEEL TOP RING SECTION



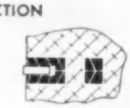
TOP RING SECTION

FRONT VIEW SECTION

Again, Zollner engineering leadership provides another great piston development to engine builders. The new Zollner "Perma-Groove" gives sensationally longer life to pistons and rings, prevents blow-by, minimizes oil consumption. The light weight segmental steel section incorporates high wear resistance in the top ring groove *plus* the advantage of cool operation. Designed especially for gasoline engine pistons, "Perma-Groove" is the quality, low-weight and low-cost companion to the popular "Bond-O-Loc" piston for Diesel engines. We suggest an immediate test of "Perma-Groove" advantages for your gasoline engine.

*T. M. Reg. Pat. App. For

OUTSTANDING ADVANTAGES OF ZOLLNER "PERMA-GROOVE" TOP RING SECTION



CROSS SECTION

1. Individual steel segments eliminate continuous band expansion problem.
2. Segments securely locked to prevent radial movement.
3. Dovetailed edges keep steel segments securely in plane with groove.
4. 75% steel bearing area for wear resistance.
5. 25% aluminum bearing area for heat conductivity and cool operation.
6. Light in weight.

ADVANCED ENGINEERING

PRECISION PRODUCTION

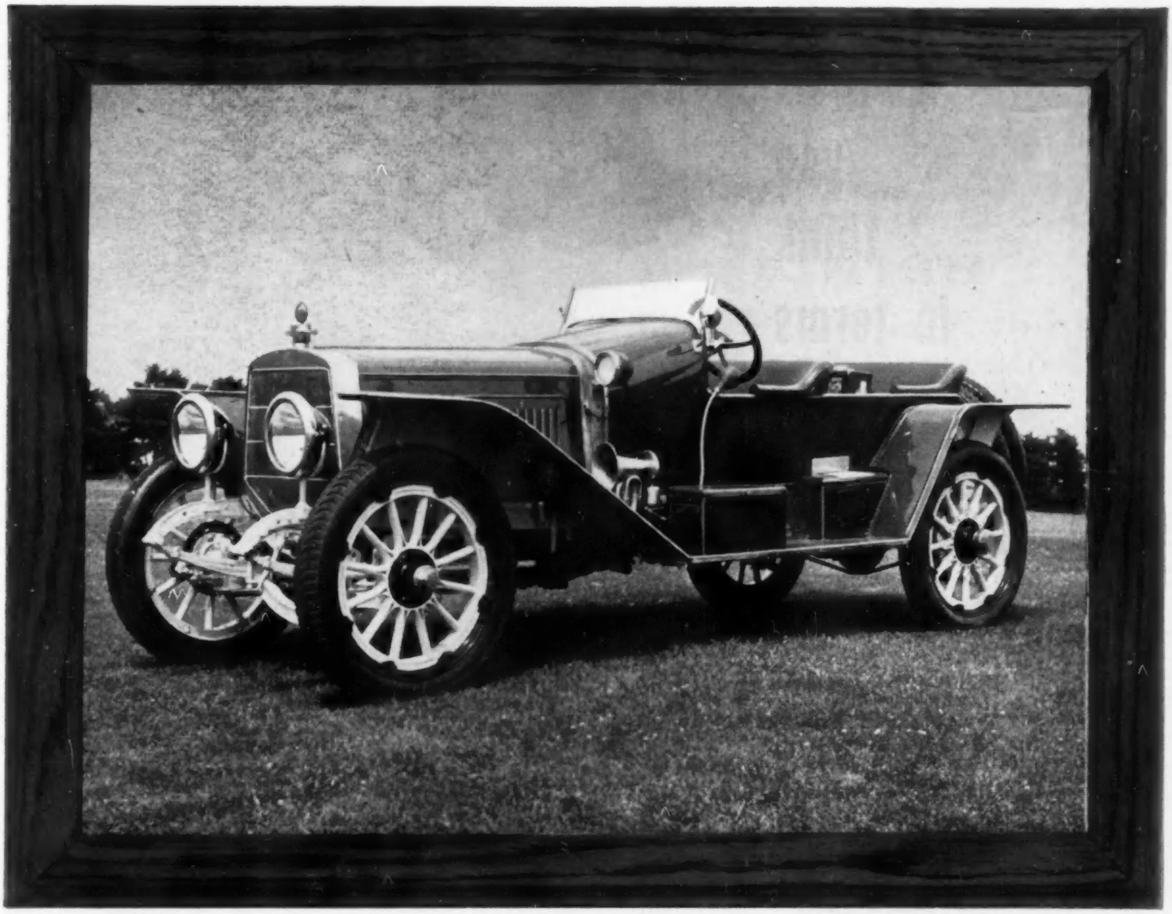
COOPERATION WITH ENGINE BUILDERS

ZOLLNER PISTONS

THE ORIGINAL EQUIPMENT PISTONS

ZOLLNER

ZOLLNER CORPORATION • Fort Wayne, Indiana



Send for free print—1913 Lozier. This print, from collection of P. S. DeBeaumont, not for commercial use.

"Legitimately high-priced," the 1913 Lozier cost over $5000. It featured a modified toy tonneau body, a T-head six-cylinder engine with 51 h.p. and a top speed of 81 m.p.h. Ignition was dual battery and magneto. From 1907 to 1911, the Lozier maintained an enviable racing record. This is one of a series of antique automobile prints appearing in Morse advertisements. Write for your free copy, suitable for framing, to: Morse Chain Company, Ithaca, N.Y.

Over 75,000,000 Morse Timing Chains insure long service life of cars, trucks, and buses

On nineteen of the twenty-two current makes of cars, *Morse Timing Chain Drives* are specified as original equipment. Over the years, the auto industry has used more than 75,000,000 of these durable Morse Chains. Precision-built Morse Drives give car, bus, and truck owners long service life—plus freedom from maintenance worries.

If you have problems involving timing chain in design, development or application, check first with Morse. We have expert engineering service available to help you solve them quickly, profitably.

For further information, call, wire, or write: MORSE CHAIN COMPANY, ITHACA, NEW YORK.

MORSE BW* POWER TRANSMISSION PRODUCTS

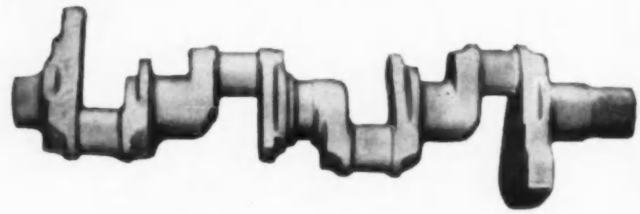
*Trademark

whether you think in terms of

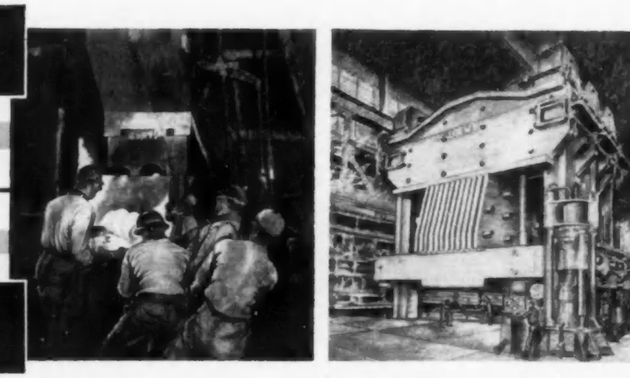
Horsepower

— or —

Thrust

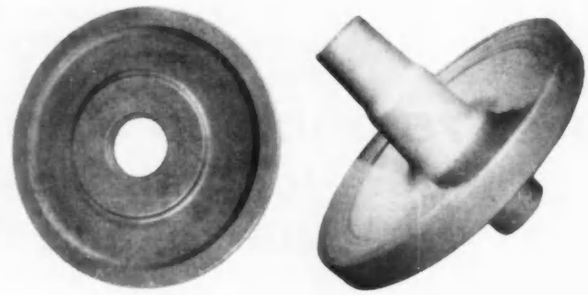


The crankshaft is the backbone of the piston-type engine. Illustrated above is the crankshaft forging for the most powerful piston-type aircraft engine ever produced.



The history of Wyman-Gordon's contribution to aircraft progress dates from the inception of the "flying machine". The jet age is now calling on the unparalleled resources of Wyman-Gordon, which include the widest range of hammer and press equipment and the greatest technical know-how in the industry. Larger and more intricate forgings than heretofore available of aluminum and magnesium are being produced on presses up to 50,000 ton capacity, and giant hammers are fulfilling the growing need for forgings of titanium, high density materials or so-called super alloys. Now, as for nearly 75 years, there is no substitute for Wyman-Gordon experience and ability for — Keeping Ahead of Progress.

At the bottom left is a turbine disc forging made from high density heat resisting alloy, and next to it is a titanium compressor wheel forging for two of the most powerful jet engines yet produced.



WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM
WORCESTER 1, MASSACHUSETTS
HARVEY, ILLINOIS • DETROIT, MICHIGAN

Only Firestone Truck Rims

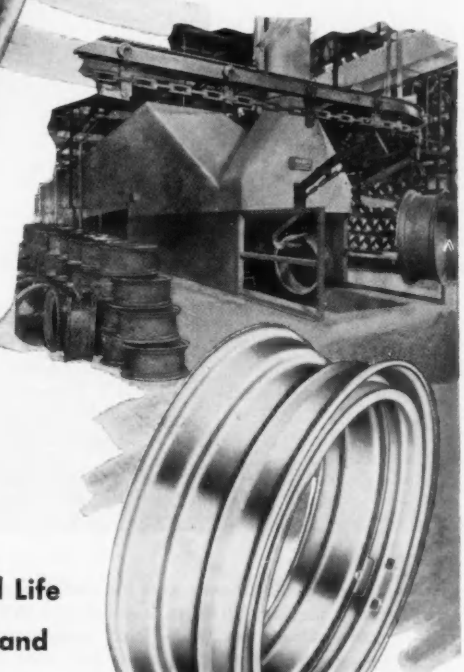
Have the Exclusive

Perma-Plate

FINISH

That Protects Against Salt and Corrosion

Here's proof Perma-Plate is not just another paint! After exposure to corrosive salt spray for 500 hours, the Firestone rim, at left, is still in good condition. Rim with ordinary finish, at right, shows severe rusting and corrosion . . . its tubeless tire sealing qualities have been impaired.



Changeover to

Firestone

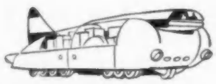
ONE-PIECE RIMS

for Tubeless Truck Tires

- Air Leakage Eliminated at Bead
- No Wobble
- Longer Tire Bead Life
- Easier to Mount and Demount

FIRESTONE STEEL PRODUCTS CO. AKRON OHIO | or Your Nearest Firestone Rim Distributor

Imagineering the 195X models ... in Alcoa® Aluminum



Heavy-duty part made 50% lighter

A heavy truck highballs down the road and WHAM it hits a big chuck hole. But the dual drive axle has a Hendrickson suspension. Two equalizer beams keep all four wheels against the road. Road shock is cut in half.

These equalizer beams must withstand heavy loads, jarring impacts and pounding vibration for hundreds of thousands of miles. Hendrickson was using forged steel beams weighing 120 lbs apiece (all unsprung weight). That's when Hendrickson began to imagineer in Alcoa Aluminum, a practice we commend to all. They called us in.

Alcoa Development Division engineers first made stress analysis studies of the steel beams. Placed in a testing machine, the beams were precisely loaded to determine the points and values of high stress and also the breaking load. Then, after mathematical analysis, our engineers designed a forged aluminum beam. Prototypes were hand-blocked and finish-forged.

The aluminum beams weighed only 60 lbs apiece, a 50% weight saving—120 lbs per vehicle. Now if they could take the loads and the pounding . . .

The beams were run through an exhaustive series of static tests. Then fatigue-tested at double-rated loads for *10 million cycles.* Then installed in actual trucks and tested in service (see below). The aluminum beams withstood the toughest tests, and thousands are now in service with no reported failures.

Every year automotive designers imagineer more and more new parts from Alcoa Aluminum. Our Development Division has unparalleled facilities to help *you* imagineer *your* 195X (or '6X!) models ... in Alcoa Aluminum. Call us in.

Aluminum equalizer beams were installed in a test truck at Alcoa Development Division headquarters. The truck was given a 50% overload and then driven over 8" square railroad ties. Oscillograph measurements recorded the heavy dynamic stresses on the beams. The beams withstood the toughest tests. ALUMINUM COMPANY OF AMERICA, 1844-H Alcoa Building, Pittsburgh 19, Pennsylvania.

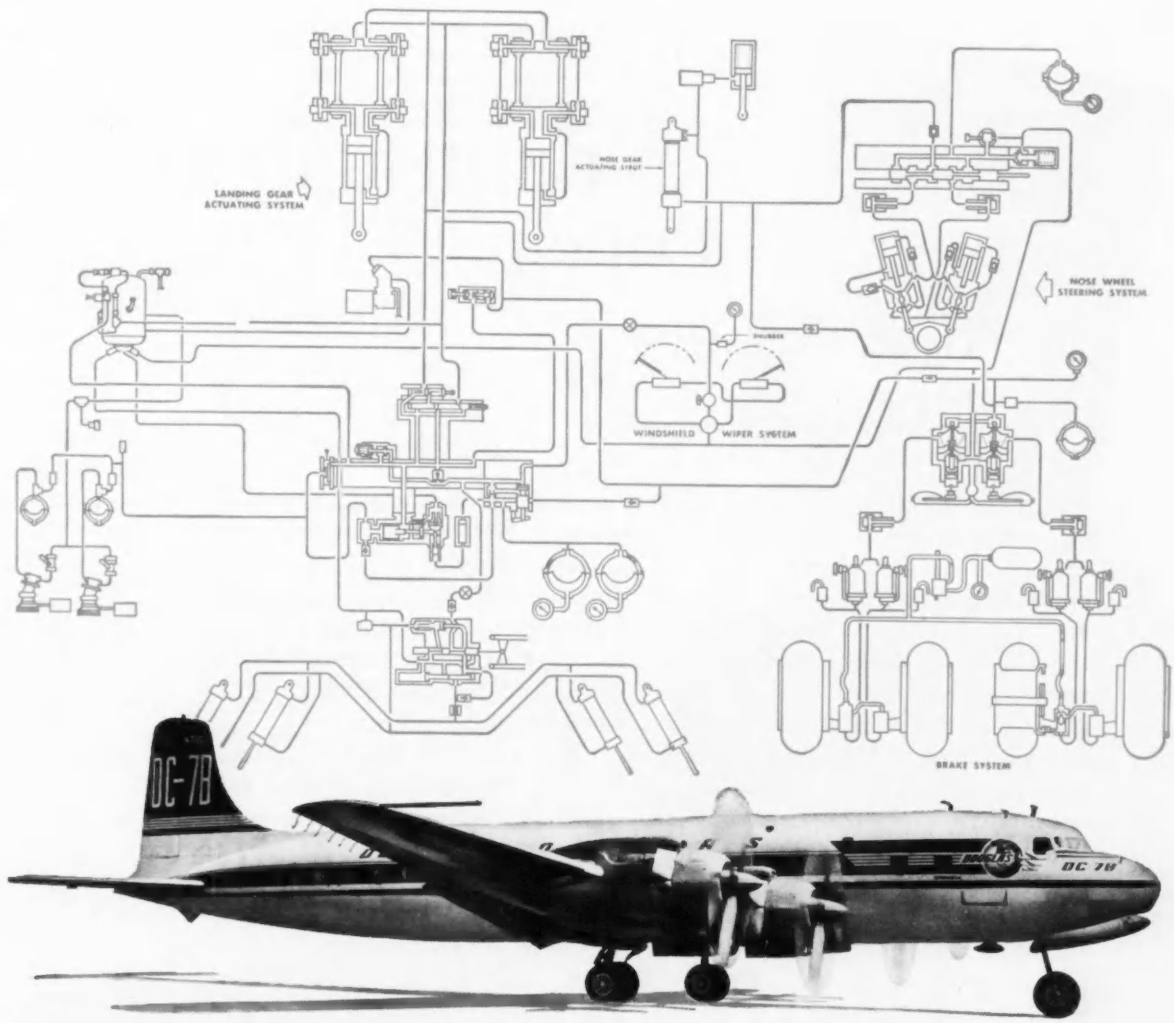
Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Always Fasten Aluminum with Alcoa Aluminum Fasteners



Enjay Butyl rubber—vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

XVI

This is the sixteenth o a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Copper: Its Principal Effects in Alloy Steels

One of the best known of all metals, copper certainly needs no introduction here. Its uses are legion. It is one of the best conductors of heat and electricity. It is popular with the housewife, essential to the engineer. But possibly not so well known is its very important function as an alloying element in certain types of steels. So used, copper increases resistance to atmospheric corrosion and also acts as a strengthening agent.

Since copper does not oxidize in the steel melt, it can be added at any time during the course of the heat. Pure copper melts at about 1980 deg F.

Copper is added to steel in varying amounts. The actual proportion, of course, depends upon the end product in mind. Some of the most widely used copper-bearing steels are those containing from 0.20 to 0.50 pct. In these, copper has been found to increase corrosion-resistance without materially affecting mechanical properties. It has been found, too, that paint frequently lasts longer on such steels than on the non-copper-bearing types.

Among the best known of the copper-bearing steels are the high-strength, low-alloy grades developed in recent years. Generally speaking, the ductility of steels in this group is comparable to that of conventional structural steel. The yield strength, however, is usually higher. Copper, working as a team with chromium, nickel, and phosphorus, substantially raises the level of corrosion-resistance in these steels; yet its presence does not adversely affect welding characteristics.

Copper-bearing steels are a subject in themselves, a subject in which Bethlehem metallurgists are well versed. If you would care to know more about this interesting group of steels, feel free to consult with our technicians. They will gladly work closely with you and help with any problems you may encounter. And please remember, too, when you need alloy steels of any kind, that Bethlehem manufactures the full range of AISI standard alloy grades, as well as special-analysis steels and all carbon grades.

If you would like reprints of this entire series of advertisements, Nos. I through XVI, please write to us, addressing your request to Publications Dept., Bethlehem Steel Company, Bethlehem, Pa. The material is now available in a convenient 32-page booklet, and we shall be very glad to send you a free copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

more dependable starting *under all operating conditions*

"No Kick-Out" feature sets new standards in starting performance.

Since the earliest days of the automotive industry Bendix* Starter Drives have been noted for reliable starting.

Now with the new and latest Bendix Folo-Thru Starter Drive, starting, even under the most adverse weather conditions, has been improved immeasurably.

Although this new Bendix Starter Drive is fundamentally similar to its illustrious predecessors, it is specially designed to follow through the weak explosions until the engine actually runs on its own power.

That's why cars, trucks and buses equipped with the Bendix Folo-Thru Drive are easier and quicker to start under all operating conditions.

*REG. U.S. PAT. OFF.

ECLIPSE MACHINE DIVISION OF Bendix AVIATION CORPORATION

ELMIRA, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

Bendix folo-thru starter drive

costs less—*The new Folo-Thru Drive requires no actuating linkage and the less expensive solenoid may be placed in any convenient position. Results are lower installation costs and no adjustments. Complete detailed information is available on request.*

Bendix* Folo-Thru Starter Drive · Bendix* Automotive Electric Fuel Pump · Stromberg* Carburetor

air-conditioned cover keeps new clutch c-o-o-l

Frictional heat has little effect on the new *Lipe* Direct Pressure Clutch. Air circulating through the cover's 33 ventilating holes dissipates heat rapidly. The result is a heavy-duty clutch singularly free of burned facings and warped pressure plates. A clutch whose low maintenance cost matches its low first cost.

Lipe Direct Pressure Clutches now available: 13", 14", 15" single-plate, 14" and 15" two-plate. Send for complete information.

For the name of your nearest Authorized Lipe Distributor, look under "Clutches" in your telephone directory. Or, write us.

Manufacturers of Automotive Clutches & Machine Tools

Lipe-ROLLWAY
CORPORATION
SYRACUSE 1, N. Y.

"My name is Mary Lou.
I live at 916 Indian Road.
I am a good girl. I never, never play in the street.
Naughty girls play in the street so please drive carefully.
Even naughty girls are too young to have to go to heaven.
Watch out for naughty girls because sometimes even good little girls are naughty.
Please drive carefully."

The above message is brought to you in the interest of safer driving by Auto Specialties Mfg. Co. of Saint Joseph, Michigan, where we raise a lot of good little girls who sometimes run into the street and, incidentally, where we manufacture safer automobile brakes . . . Auto Specialties Double-Disc Brakes. They are ready for cars now.

You can stop smoothly and in a straight line at high or low speeds with Auto Specialties Double-Disc Brakes.

In a "panic stop" your brakes won't cause you to swerve. You'll have a better chance to maintain control of your car when it's equipped with Double-Disc Brakes.

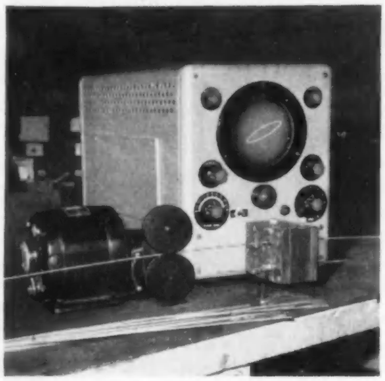
Their adoption will be in keeping with increased horsepower, speed and with the industry's continuing desire to give the American motorist better, safer and more pleasant means of transportation.

For more information on these brakes, a 16-page, 4 color, illustrated booklet is available free. Write for "The Stopping Story." *And if you're driving today, watch out for Mary Lou.*

AUTO SPECIALTIES MFG. CO., INC. Saint Joseph, Michigan

Plants also at Benton Harbor and Hartford, Michigan and Windsor, Ontario, Canada
Manufacturing for the automotive and farm machinery industries since 1908

SPOTCHECK PINPOINTS DANGER AREAS in heavy machinery and operating equipment. The Spotcheck dye penetrant inspection kit is excellent for testing during maintenance, or for intermittent spot testing for cracks and other surface defects. Kit contains all materials in easy-to-use pressurized spray cans plus a handy, lightweight carrying case.



NOW YOU CAN "SEE" DEFECTS in wires, rods and tubes of low conductivity metals such as aluminum, tungsten or uranium. The FW-200 Series unit sets up eddy-currents in the test materials. Using frequencies from 15 KC to 2 MC, any cracks, splits or seams are detected and easy-to-read indications are shown on the TV-type picture tube. Diameter changes register separately. Adjustments can be made for a visible signal and automatic rejection of defective materials.

HALLMARK OF QUALITY IN NONDESTRUCTIVE TEST SYSTEMS

MAGNAFLUX CORPORATION

Write for complete details concerning any of the above case studies, or ask for our new booklet on "Lower Manufacturing Costs."

Case Studies:
NONDESTRUCTIVE TESTING SYSTEMS

Type ZA-29 Zyglo unit is widely used and accepted for detecting surface defects in aluminum magnesium, brass and titanium parts.

How Production, Payroll and Public Relations Can Benefit from "Early-Stage" Testing

The most for the least, that's what your customers want today. To help answer these demands and still show a profit, you can increase the output and quality of production without increasing costs and facilities.

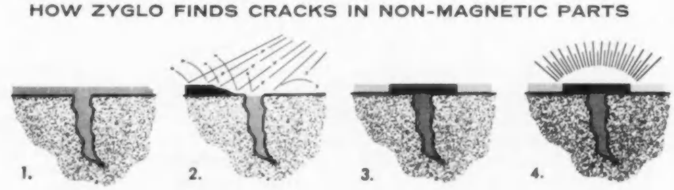
By supplying process control and by maintaining consistent quality standards, Magnaflux nondestructive testing systems provide a quick, accurate, economical production tool. They can increase output and lower your operating costs. M methods save money by keeping production at a dependable level.

M methods provide an "early-stage" test for the detection of surface defects in all magnetic and non-magnetic metals, ceramics, glass and other solid materials. "Early-stage" testing pinpoints improper procedures and corrective steps can be taken to eliminate the manufacture of defective parts. Where serious defects do occur, parts can be rejected before further effort is wasted on additional processing. When defects are minor, repairs can be made to decrease scrap losses and upgrade salvage operations.

"Early-stage" testing with M methods pays in many ways. It increases usable production output, it prevents unnecessary payroll costs on defective materials, it protects your reputation by insuring consistent quality, all of which means dollar savings to you!

Find out how low-cost Magnaflux nondestructive test methods can help protect your company's quality, pocketbook and name. Write, or call on a Magnaflux testing systems engineer today.

HOW ZYGLO FINDS CRACKS IN NON-MAGNETIC PARTS



1. A surface film of Zyglo penetrant is applied to parts by dipping, spraying or brushing. After this application, penetrant enters any surface opening, cracks or pores, and excess penetrant is allowed to drain off. 2. Parts are then washed with a water spray, and permitted to dry. 3. Next, parts are dipped in a developing powder. This acts as a blotter, and draws the penetrant to the surface. 4. Look at the part under "black light". Any crack or surface defect will show up as a glowing fluorescent indication that is impossible to miss. Scratches will not be shown.

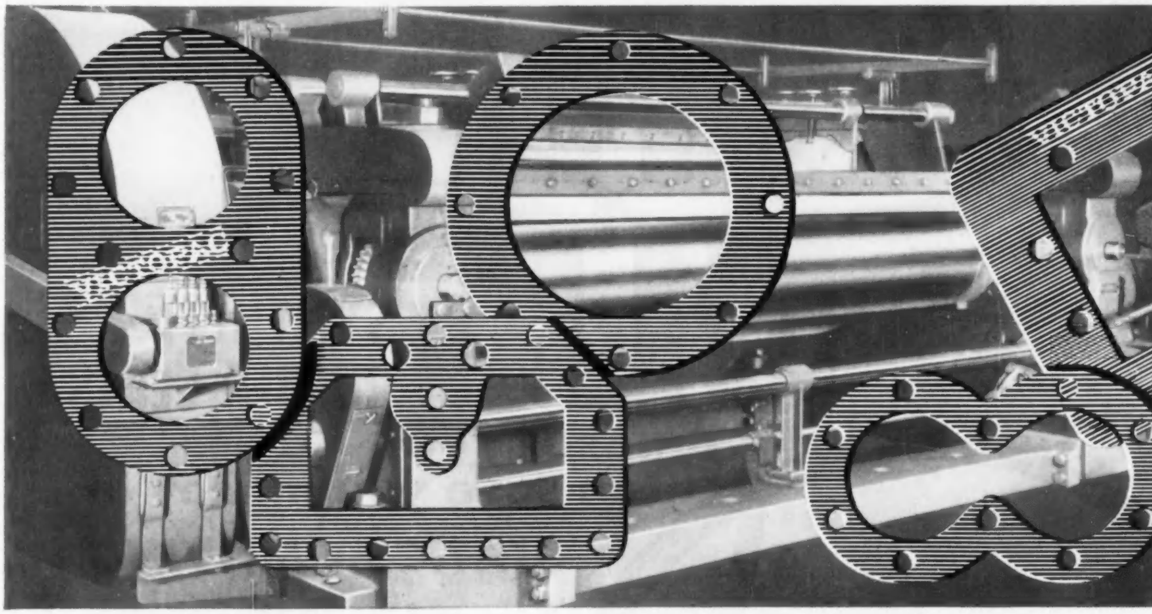
Take Your Inspection Problems to the House of Answers

MAGNAFLUX CORPORATION

7348 West Lawrence Avenue • Chicago 31, Illinois

New York 36 • Pittsburgh 36 • Cleveland 15 • Detroit 11 • Dallas 19 • Los Angeles 58

Now VICTOPAC for Everyone!



VICTOR doubles production of this versatile asbestos-synthetic rubber sheet packing

Sealing engineers agree on Victopac synthetic rubber and compressed asbestos sheet packing. Its known consistent performance on automotive and industrial applications has created unprecedented, still growing demand. By adding new specialized machinery, Victor has increased production and is now able to fill your orders promptly, whether for sheets or finished gaskets.

SERVICE RECOMMENDATIONS

Victopac is the proven economical specification for sealing hot or cold water . . . steam . . . vapor . . . combustion engine fuels, lubricants or coolants under high fluid and heavy flange pressures. It is a highly developed long-fiber asbestos-synthetic rubber composition, compressed and bonded under heat. In sheet form it is tough and completely homogeneous, with unlimited usefulness.

MEETS SAE-ASTM SPECIFICATIONS

In its several basic types, Victopac conforms to SAE-ASTM specifications G-1111, G-1122 and G-1123. Made in standard sheet thicknesses up to 1/8"—in sheet sizes up to 58" x 62½".

TEST SAMPLE SHEETS SUPPLIED

Your inquiry invited for sample sheets. Please write on business letterhead, stating proposed application. See your Victor Gasket Engineering Catalog No. 505 for complete technical data.

Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. In Canada: Victor Mfg. & Gasket Co. of Canada Ltd., Victor Dr. and Chester St., St. Thomas, Ont.

VICTOPAC CONDENSED SPECIFICATIONS

Type	SAE-ASTM Spec.	% Compression 5000 p.s.i. Load	Recovery %	Minimum Original Tensile	Max. Thickness Change in ASTM Oil No. 1—5 hrs. at 300° F.
1	G-1111-1	12 ± 5	40	1800 p.s.i.	20%
1	G-1111-2	20 ± 5	40	1250 p.s.i.	20%
1B	G-1111-1	12 ± 5	40	1800 p.s.i.	20%
2 Graphite coated, one side	G-1111-1	12 ± 5	40	1800 p.s.i.	20%
3 Graphite coated, two sides	G-1111-1	12 ± 5	40	1800 p.s.i.	20%
50V	G-1122-1	12 ± 5	40	2000 p.s.i.	10%
60V	G-1123-1	12 ± 5	40	2000 p.s.i.	15%

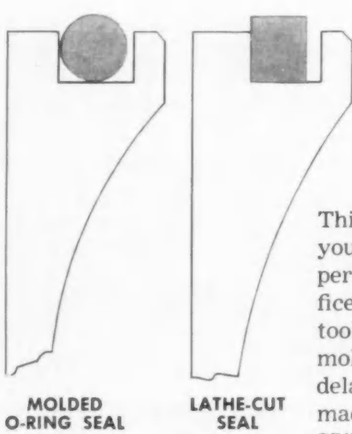
VICTOR

Sealing Products *Exclusively*

GASKETS • OIL SEALS • PACKINGS

Why ACADIA LATHE-CUT SYNTHETIC RUBBER SEALS

can save you money in *STATIC* or *MOVING* seal applications



This seal will save you money with no performance sacrifice. Minimum tooling cost, no molds, no costly delays. Can be made up to 25" I.D.

Acadia Synthetic Rubber Parts are of the highest quality components, processed for oil resistance, good aging properties, resistance to heat. They can be furnished in any dimension or special compound you desire to precision tolerances. They are another example of Acadia's ability to SAVE YOU MORE..SERVE YOU BETTER.

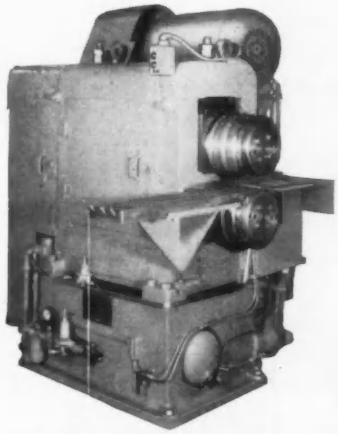
There's an Acadia Sales engineer near you to serve you. Write us today, and we'll put him in touch with you immediately.

ACADIA *Synthetic* **PRODUCTS**

DIVISION OF WESTERN FELT WORKS
4021-4139 West Ogden Avenue, Chicago 23, Illinois

Branch Offices LOOK in the 'Yellow Pages' in Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT



from the forging roll . . .

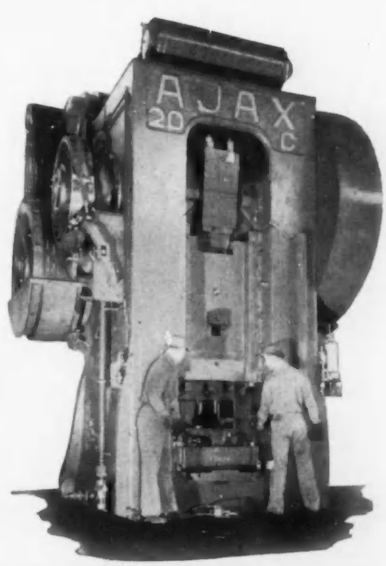
AJAX WIDE ADJUSTMENT FORGING ROLLS

PRE-ROLL YOUR FORGING BLANKS • • •

FOR METAL SAVING • LONGER DIE LIFE • BETTER FIBRE FLOW

AJAX ROLLS are built in seven sizes to pre-roll forging blanks ranging from Connecting Rod blanks to the largest Airplane Propellers. Illustrations show Automobile Connecting Rod blank formed (above) and press-forged (below) on **AJAX HIGH SPEED FORGING PRESS.**

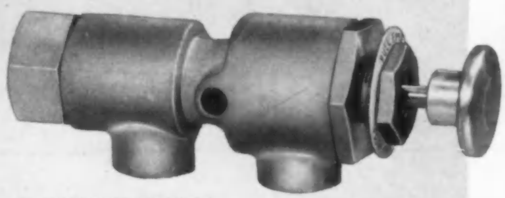
. . . to the forging press



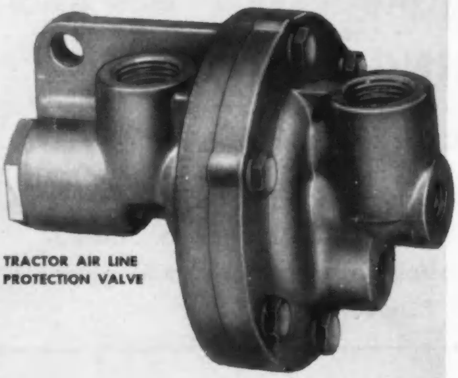
WRITE FOR BULLETIN 91-B

THE **Ajax** MANUFACTURING COMPANY
EUCLID BRANCH P. O. CLEVELAND 17, OHIO
110 S. DEARBORN ST., CHICAGO 3, ILLINOIS
W. P. WOOLDRIDGE CO. • BURLINGAME, CAL. • LOS ANGELES 22, CAL.

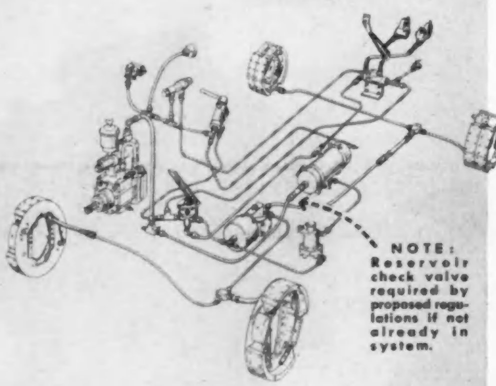
Now . . . you can give tractors both MANUAL and FULLY AUTOMATIC protection!



EMERGENCY BRAKE VALVE



TRACTOR AIR LINE PROTECTION VALVE



Wagner's two *new* tractor valves in combination with ANY trailer emergency (breakaway) valve protect tractor-trailers —meet all new I. C. C. regulations!

The emergency brake valve triggers emergency braking on the trailer and may be operated manually, at any time, or will automatically operate when air loss drops pressure to a pre-determined value.

The towing vehicle is protected by the tractor airline protection valve which automatically isolates the tractor air supply and provides normal brake control of the tractor in the event of a pressure loss on the trailer.

These Two New Valves Provide these Superior Advantages

Manual and fully automatic protection
Emergency braking may be triggered at any time by merely pulling the valve knob; however, the fully automatic application requires no special thought or action on the part of the driver in any emergency due to trailer breakaway or air loss failure.

Compatible with all makes of trailer equipment
Trailers equipped with air brakes of popular manufacture may be freely interchanged.

Tested automatically
Valves are automatically and completely tested each time a trailer is coupled and uncoupled.

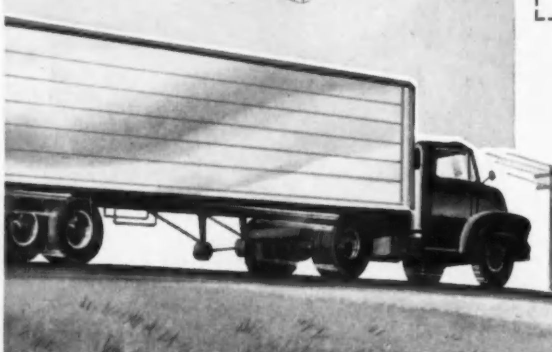
Simplifies the driver's job
No need to climb on tractor to open or close shut-off cocks. All driver does after making "glad-hand" hose connections is to depress the emergency brake knob, completely charging the trailer air brake system. Contact your local Wagner Air Brake Representative—or write for Bulletin KU-281.

Choice of Three Installation Kits

For installing new tractor air brake system:
Kit No. A23348— includes reservoir check valve
Kit No. A23349— without reservoir check valve

For converting tractor air brake system:
Kit No. A23351— includes check valve
Kit No. A23352— without check valve

For modifying systems presently equipped with Wagner tractor protection valves
Kit No. A23367— includes check valve
Kit No. A23368— without check valve



Wagner Air Brake Systems

Wagner Electric Corporation 6378 Plymouth Ave.
ST. LOUIS 14, MISSOURI

K56-8B

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID • NoRoL • CoMoX BRAKE LINING • AIR BRAKES • AIR HORNS • TACHOGRAPHS • ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES

Let our experience help you

For more than forty years manufacturers in every industry have availed themselves of Bohn's technical skill and fabrication know-how. The benefits of Bohn's wide experience in extrusions, castings and forgings and other fabricated products are available to you. Let us quote on your specifications. Send us your blueprints today!

BOHN ALUMINUM AND BRASS CORPORATION

1400 LAFAYETTE BLDG., DEPT. S
DETROIT 26, MICHIGAN

SALES OFFICES:
Boston • Chicago • Cleveland • Dayton
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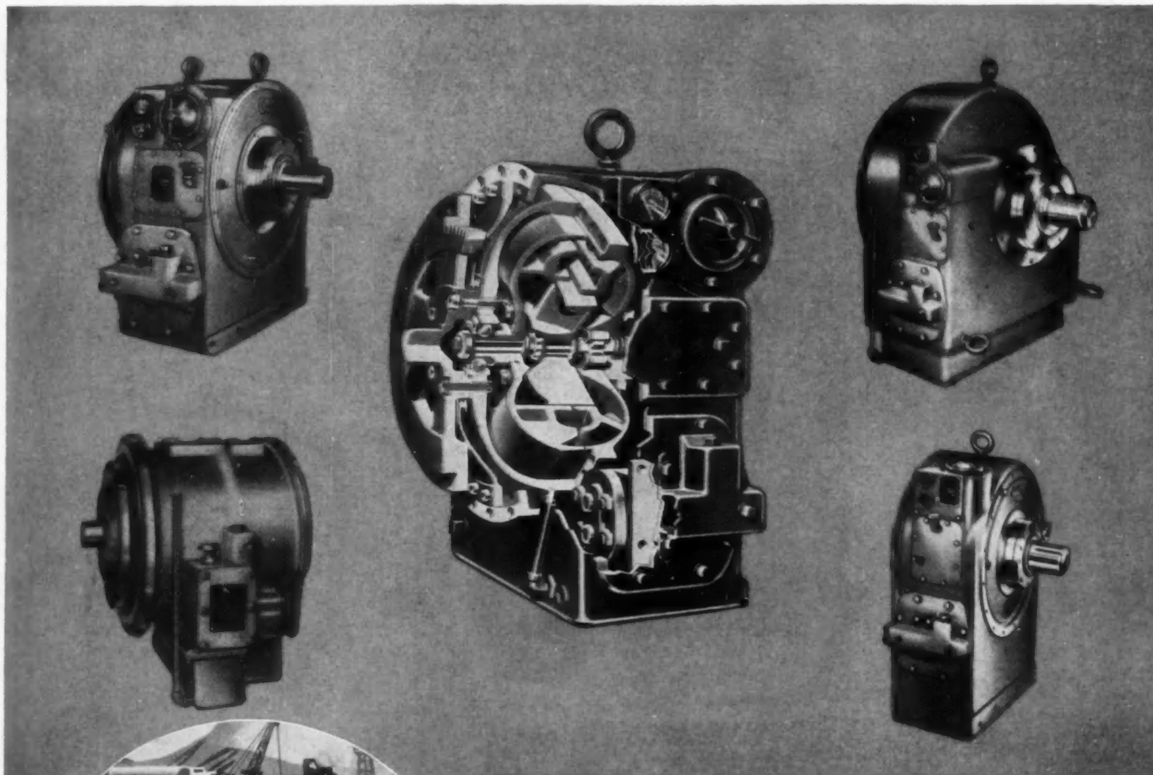
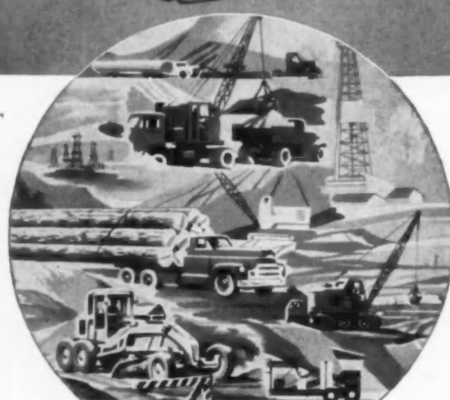
BRASS ROD • BRASS AND BRONZE INGOTS • PISTONS • BEARINGS • FORGINGS • EXTRUSIONS • CASTINGS • REFRIGERATION AND AIR CONDITIONING PRODUCTS





For your power need, *whatever it is,* there's a "right" TORCON Model

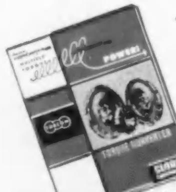
With a horsepower range from 15 to 600, and fly-wheel diameters from 11 to 26 inches, Torcon has a model that's right for your need — a standard unit available immediately for original equipment or for field installation.

Your real benefits begin after Torcon is installed—

- **more work and less wear: Torcon blade design balances engine efficiency and horsepower through the working range—smooth, shockless power that reduces wear, prolongs life**
- **integral unit includes oil pump, sump, pressure regulator; much better efficiency with minimum maintenance**

Are you constantly on the look-out for ways to get more efficient power at less cost? Talk to Clark—on all problems of power transmission, from flywheel to point of torque application. You'll find, as do many leading equipment manufacturers, that it's "good business to do business with Clark".

SEND FOR THIS TORCON BULLETIN

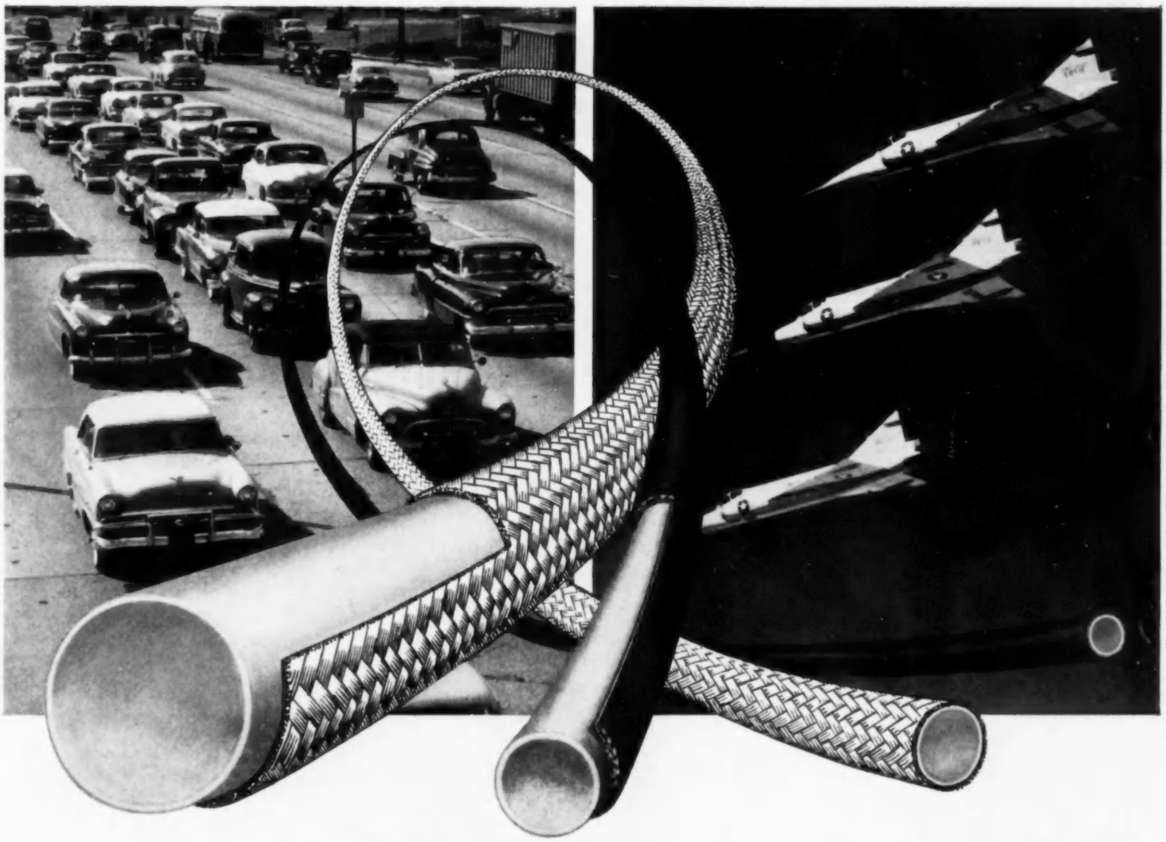


—a concise, helpful statement on how Torcon installations cut operating costs, prolong equipment life.

CLARK® EQUIPMENT

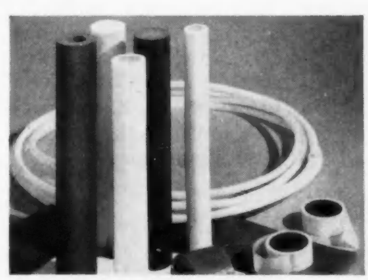
CLARK EQUIPMENT COMPANY, Transmission Division
Falahee Road • Jackson 5, Michigan

Other Products of the Clark Automotive Division . . . TRANSMISSIONS • AXLE HOUSINGS • TRACTOR UNITS • TORCON TORQUE CONVERTERS • ELECTRIC STEEL CASTINGS • GEARS and FORGINGS • FRONT and REAR AXLES for TRUCKS, BUSES and OFF-HIGHWAY EQUIPMENT.



BEAT CORROSION AND FATIGUE

with the hose that can take it



Other R/M "Teflon" products for the automotive and aviation industries include rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded rods and tubes; Raylon—a mechanical grade of "Teflon" with many of the characteristics and properties of virgin "Teflon." For details, call or write R/M.

Wherever hose must really stand the gaff, your best bet is R/M Flexible Thin-Wall "Teflon"* Hose.

This new hose—stainless steel wire-braided or rubber covered—features extreme flexibility and does not expand, contract or fatigue. It also has great resistance to high temperatures and corrosive lubricants. The braided jacket type meets MIL-5511 specifications in all designated sizes.

This contribution to better performance and greater safety on the road and in the air is a result of R/M's long experience with "Teflon." Ever since it first came into use, our laboratories have been developing the vast potentialities of this material for all phases of industry. Write for complete information.

*Du Pont trademark

R/M

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

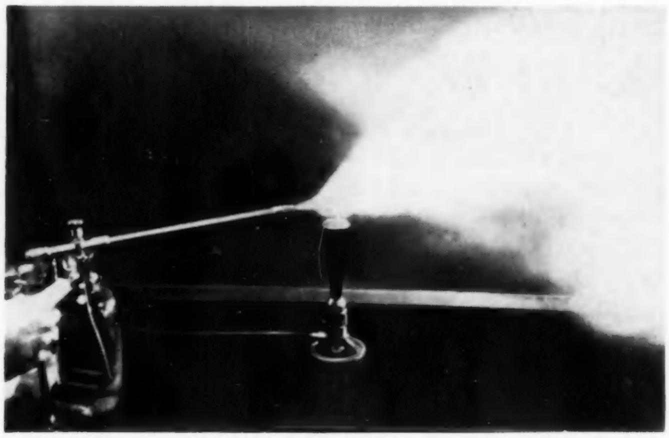
RAYBESTOS-MANHATTAN, INC., Engineered Plastic, Industrial Rubber and Sintered Metal Products • Packings • Asbestos Textiles • Abrasive and Diamond Wheels
Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Laundry Pads and Covers • Bowling Balls

Announcing...the First

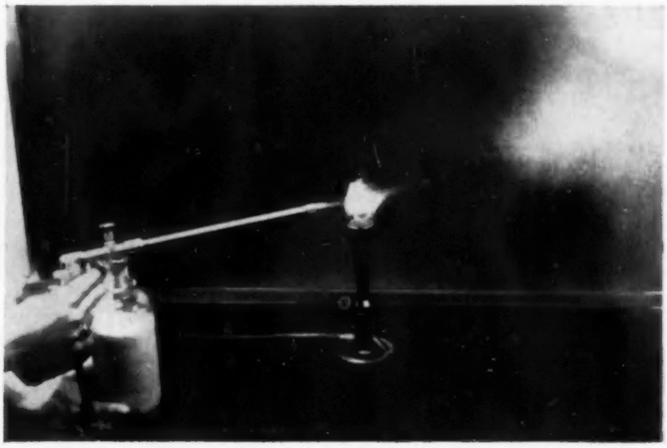
HYDRAULIC

Flame tests prove its fire-snuffing ability

This photo shows the instant combustion taking place when a conventional hydraulic oil of mineral oil type is atomized over a Bunsen burner.



In this photo, Shell Irus Fluid 902 replaces the mineral oil. Note that there is no ignition.



SHELL IRUS FLUID 902

Oil-Base fire-resistant FLUID

SHELL IRUS FLUID 902

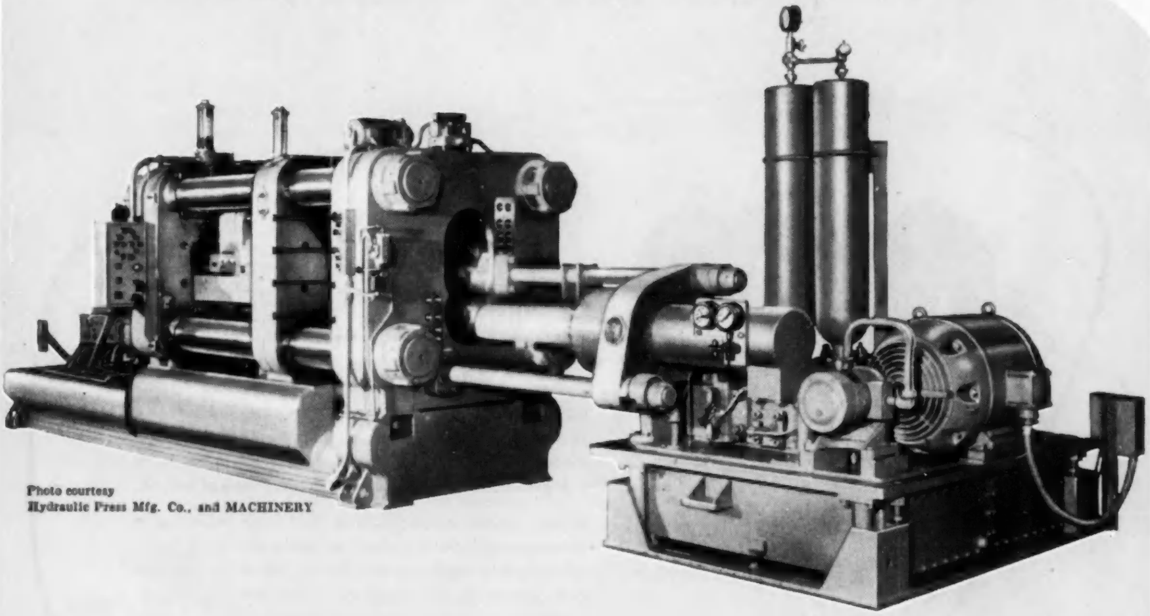


Photo courtesy
Hydraulic Press Mfg. Co., and MACHINERY

AFTER THREE YEARS of intensive research, field application and evaluation, Shell Irus Fluid 902 is now commercially available for use in industrial hydraulic systems. While its cost is far lower than other fire-resistant fluids, its performance is comparable.

No major modification of equipment is necessary. Shell Irus Fluid 902 is a special formulation containing no corrosive ingredients . . . no adverse effect on seals or fittings. It is a direct replacement for hydraulic oils now in service.

Noncorrosive, and nonrusting. Steel and copper panels immersed in Irus Fluid 902 for one week at 160°F have shown no significant signs of corrosion. Rusting has not been a problem in long-continued field tests.

This is an efficient fire-snuffing hydraulic fluid that can be widely used. Send coupon for details.

SHELL OIL COMPANY

50 WEST 50 STREET, NEW YORK 20, NEW YORK

100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL OIL COMPANY
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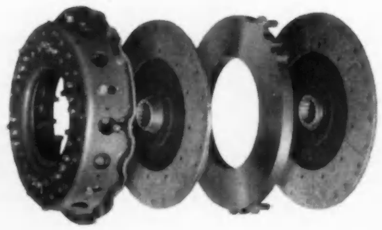
A complete line of Roller Bearings

New equipment, expanded departments, added technical personnel and increased productivity all help to make Long your ideal "production partner."

But you'll discover Long's real plus factors in our management-engineering team. Its talent for creating high quality products with economical design and volume manufacturing advantages is your biggest profit potential.



DOUBLE-PLATE CLUTCHES BOOST TORQUE CAPACITY

Available in many sizes, Long's double-plate clutches with high-gripping action anticipate advancing horsepower and torque requirements in trucks, tractors, off-highway vehicles and industrial applications. Like Long single-plate clutches, these heavy-duty production models are individually tailored by our engineers to performance requirements of any size or type of vehicle.

Long-innovated clutch features that have set industry standards include dry discs, variable springing, high-ventilation triangular covers, spring vibration dampers and cushion segments. Ask us to recommend an application conforming to your specifications.

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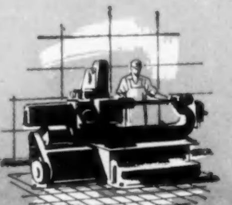
For every field of transportation and industry

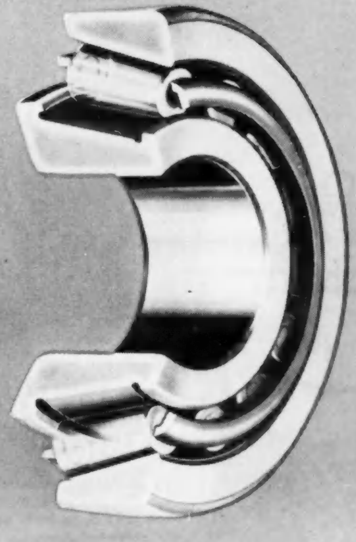


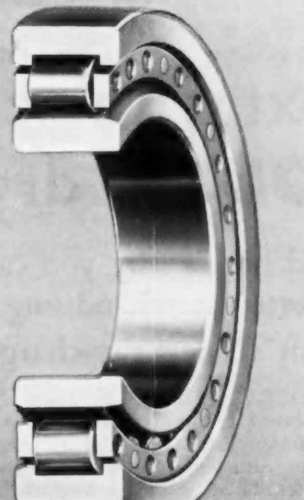
Job-tailored in a wide range of sizes to fit your specific needs

Aircraft? Automobiles? Earth-moving or farm equipment? *Whatever* you make, if your product uses straight or tapered roller bearings, Bower can meet your specifications *exactly*. For dependable Bower bearings are virtually custom-built to the job . . . engineered and sized to match any requirement.

Important, too, are exclusive Bower design features that assure long life, top performance, *less maintenance*. And when you specify Bower bearings you can always be certain of the highest quality materials and workmanship. These reasons, of course, are why Bower straight, tapered and journal roller bearings are used by leading manufacturers everywhere—for any application.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the design stage.





SPHER-O-HONED

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.

to extra values you get with **GLOBE'S** dry-charged battery program

And here's why you can do a better merchandising job with today's finest dry-charged battery

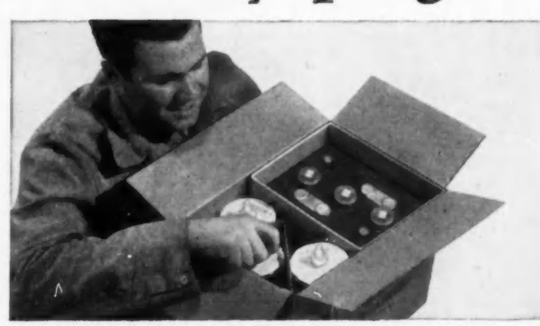
DEVELOPED and backed by Globe-Union — a name that has meant top-flight batteries and battery merchandising for nearly forty years — this recently introduced program has but one aim. And that's to make *your* battery selling easier, more profitable . . . a better buy for both you and your customers.

With dry-charged batteries, you eliminate trickle charge, standing loss . . . assure your customers of factory-fresh starting power. But when you "go with Globe," you get a host of additional values. You deal with a single, compact carton — a carton that contains battery, electrolyte and pouring sleeve. It's easier to stock and handle. And traffic-stopping design promotes striking, buy-compelling displays.

But the Globe extra value story doesn't end here.

FAST DELIVERY WHEREVER YOU'RE LOCATED

The 13 strategically located Globe dry-charge battery production plants, starred at right, assure quick and inexpensive delivery on dry-charged battery shipments.



COMPACT, EASY TO STORE AND HANDLE, ALL-IN-ONE CARTON contains battery, pre-measured, top quality electrolyte . . . safety-insuring pouring sleeve with printed instructions for activation.

GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

If it's petroleum-powered, there's a Globe-built battery — right from the start!

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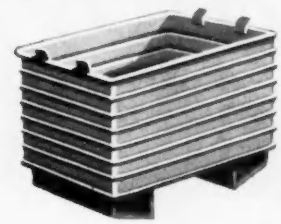

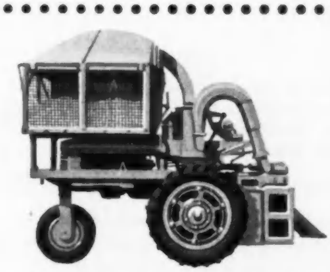

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high luster at minimum cost.

And, with all these physical advantages over mild carbon steel, it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel — long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

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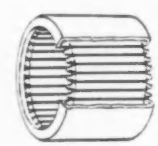
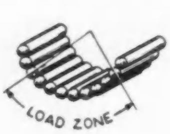
TORRINGTON

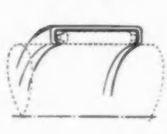
DC needle bearings give high-capacity performance in minimum space



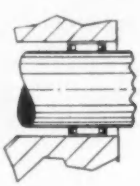
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.



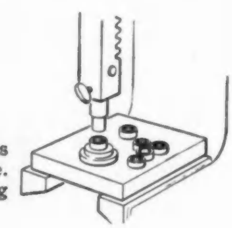
Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.



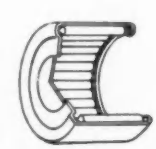
Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.



No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.



Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

See our new Needle Bearing Catalog in the 1956 Sweet's Product Design File—or write direct for Catalog No. 55.

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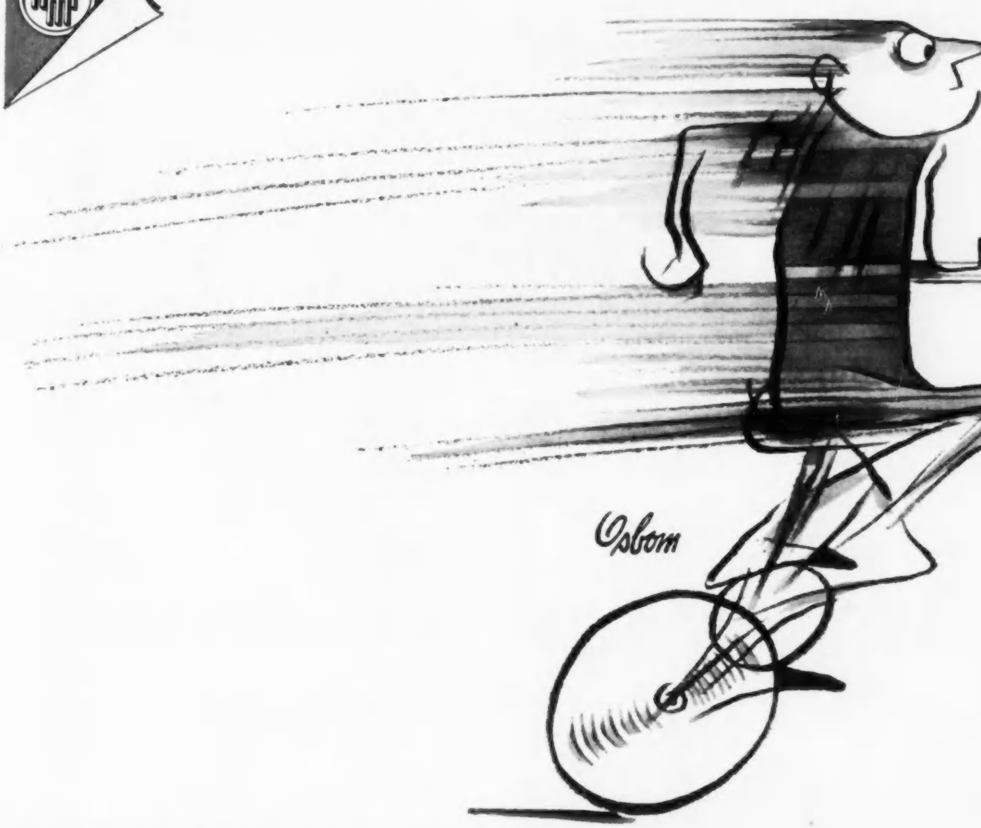


SPEED

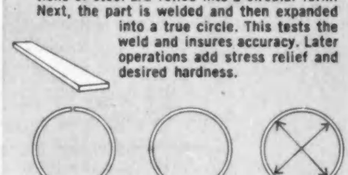
and heavier payloads are putting increased demands on today's truck and trailer rims. To meet these higher standards, more and more manufacturers specify Cleve-Weld Protecto-tire rims.

6-point "safety-age" design makes Cleve-Weld rims top performers

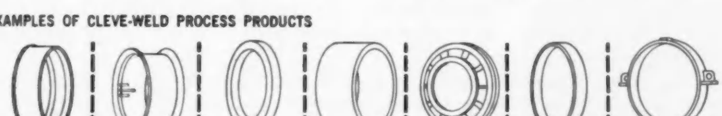
1. Rim thickened at strategic points... increases resistance to severe stress.
2. Tapered beads on both sides of rim ... tire mates firmly with the rim.
3. 28° mounting bevel... enables rim to be mounted on *all* cast wheels.
4. Lightweight construction... means higher payloads for customers without loss of strength.
5. Tire rests on tapered bead seat...tire stays put when puncture occurs.
6. Designed for any brand or type of tire... flexibility ends tire replacement problems.

For 45 years, Cleve-Weld has been a specialist in the manufacture of rolled and welded circular products. There are real dollars-and-cents reasons why *it will pay you to specify Cleve-Weld as your primary source for all rolled and welded circular parts.* We'd like to talk it over. Write address below.

THIS IS THE BASIC CLEVE-WELD PROCESS. Rectangular bars or special contoured sections of steel are rolled into a circular form. Next, the part is welded and then expanded into a true circle. This tests the weld and insures accuracy. Later operations add stress relief and desired hardness.



EXAMPLES OF CLEVE-WELD PROCESS PRODUCTS



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If this sounds like a lot, it's because North American Aviation has a lot to offer. With research, development and manufacturing responsibility for the U. S. Air Force SM-64 Navaho Intercontinental Missile, the scope of the art at North American is wide and the opportunity to assume a position of authority great. In fact, all phases of this project—research, design, development and testing—are being accomplished by North American engineers.

And what benefits will you find in this type of engineering environment?

First of all—recognition that comes from the opportunity for individual effort. You will work with engineers who respect your opinions and professional status. Because missile engineering covers so many fields, you can work in the area of your choice. You will work on a team of specialists whose leadership in their fields will further you in the one you choose. You will live in Southern California and receive financial compensation limited only by your own ability.

If you have the desire for a real engineering challenge—Investigate Now.

Contact: R.L. Cunningham, Engineering Personnel Office
Dept. SAE, 12214 Lakewood Boulevard, Downey, Calif.

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Why deal with the biggest in the business? Because complete facilities to deliver any order to your specifications are available—plus advancements and ideas that can only be offered through the experience gained by producing literally billions of rings over the years. It takes the biggest foundry in the business to produce rings for one out of three cars year after year. Isn't it time you counseled with Muskegon for your ring needs?
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REPORT FROM DU PONT:

Fuels, Lubricants and the New High Compression Ratios

Today's high compression car engines are hungry for high-octane fuels.

As a result, refiners are faced with increased costs. To help them evaluate high compression requirements and meet necessary standards economically, the Du Pont Petroleum Laboratory has completed a fuel-and-lubricant testing program with engines having compression ratios as high as 11:1.

Here is a brief résumé of the findings . . . From both laboratory and on-the-road testing, it was found that an engine with 11:1 C.R. could be operated under normal conditions—and free of combustion noise—on 100-O.N. fuel. The tests also showed that the engine design, fuel and lubricant all have a significant effect on the engine's performance. Therefore, to keep the octane requirements of high compression engines at a minimum, each of these three factors requires careful consideration.

New findings

One of the most significant findings of the tests is that high compression engines are not so critical on fuels and lubricants as was previously thought. For example, it was found that the 90% distilled point is not necessarily the criterion for measuring deposit harm of fuels. This means that refiners will have more latitude in blending the components for high compression fuels, and therefore, may be able to use more of their heavy ends in this type of fuel, without detrimental effects on engines.

Lubricants tested

The Laboratory found that multigrade oils were generally satisfactory in reducing deposit harm. A di-ester type synthetic lubricant, however, was found to be even better. This indicates that the octane requirements of high compression engines can be reduced by improvements in lubricants as well as in fuels.

Surface ignition

Even under the most adverse conditions, the tests showed surface ignition to be negligible at 9:1 C.R. At 11:1 C.R., it was much more prevalent indicating the need for careful selection of fuels and lubricants, as well as engine design.

A paper giving full details on this testing program was recently presented at the API Refining Meeting in Montreal. Just drop us a line if you would like a copy.

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Depending upon size and quantity, some HEIM Unibal Spherical Bearing Rod Ends cost 30¢ — even as low as 26¢ each. More and more manufacturers are discovering that a Heim Unibal can very often replace a special part, a weldment, assembled screw machine parts, or other specially machined component . . . which may have cost over a dollar to produce. Savings effected have run into substantial sums.

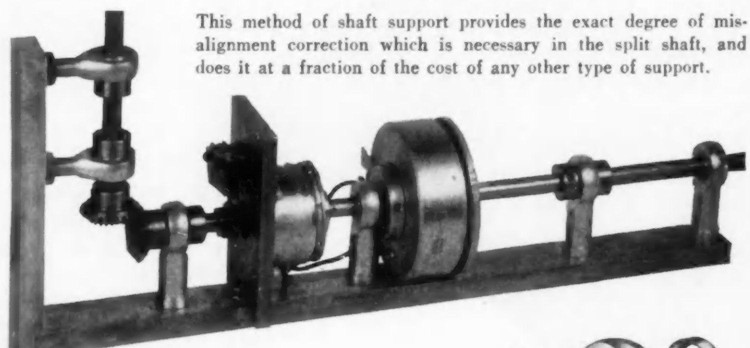
Take this clutch assembly

with its split shaft and bevel gears, as used in the Van Buskirk marking machine, as an example of how these inexpensive Heim Unibals act as adjustable, self aligning supports for both the horizontal drive shaft and the vertical driven shaft.

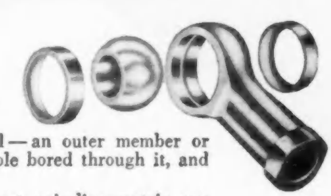
The drive shaft is supported by four female Heim rod ends, which are attached to the frame with hex-head bolts through drilled holes. The assembly is that simple.

The vertical shaft is held in place by two male Heim rod ends. These are screwed into drilled and tapped holes and locked in place with nuts and lock washers.

This method of shaft support provides the exact degree of misalignment correction which is necessary in the split shaft, and does it at a fraction of the cost of any other type of support.



THIS EXPLODED VIEW →



shows the components of the Heim Unibal — an outer member or body, a hardened and ground ball with a hole bored through it, and two bronze bearing inserts.

The universal motion of this single ball corrects misalignment in any direction. Lubrication is in the groove left between the two inserts. Grease fittings can be supplied for relubrication.

Unibal presents a larger bearing surface and can support greater axial and thrust loads.

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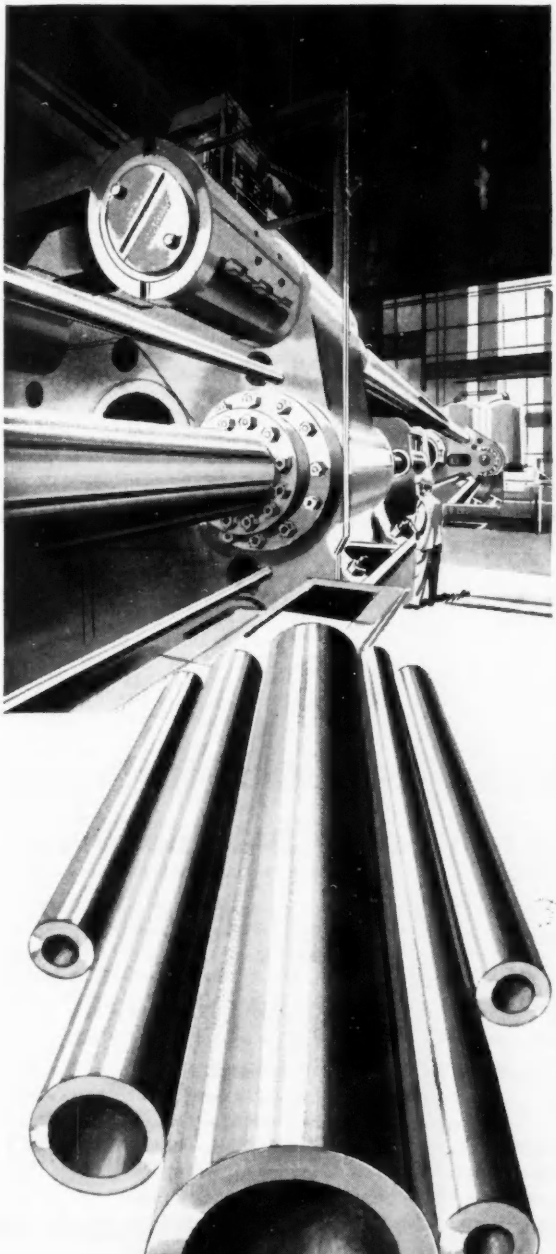

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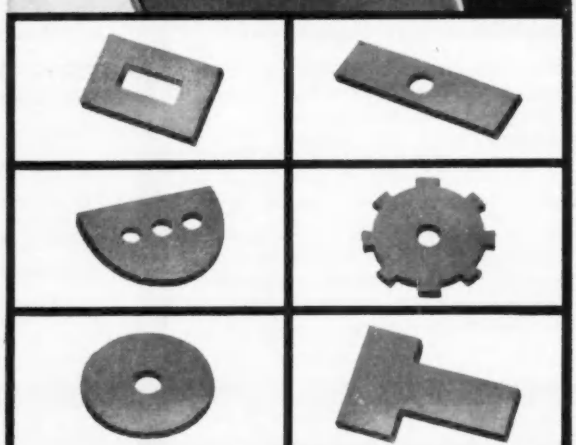

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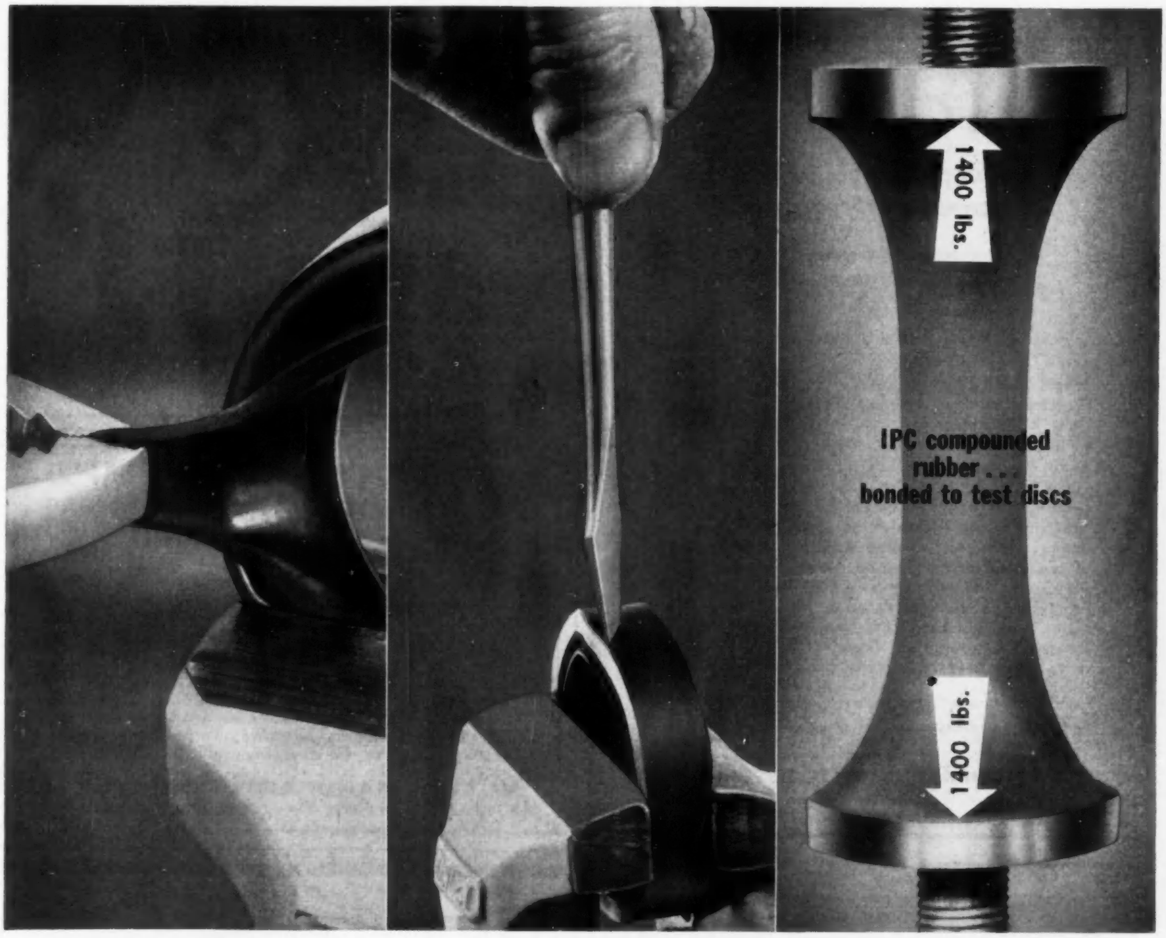

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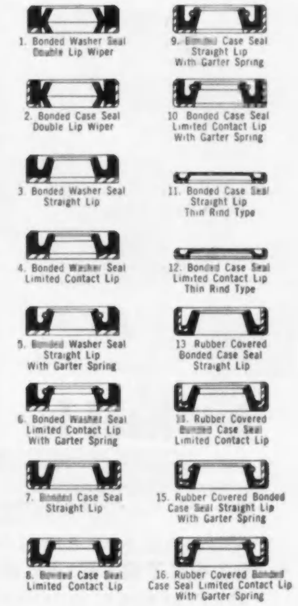

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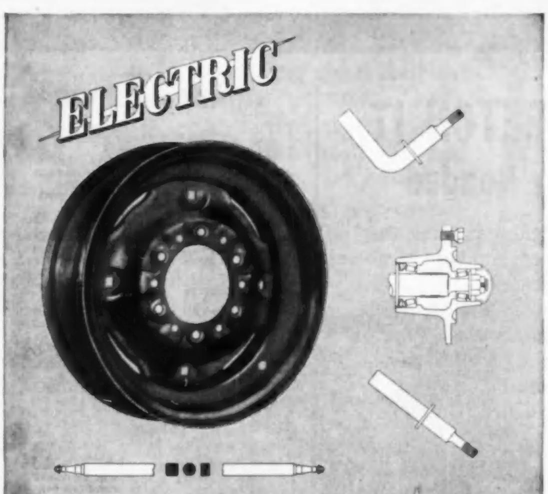

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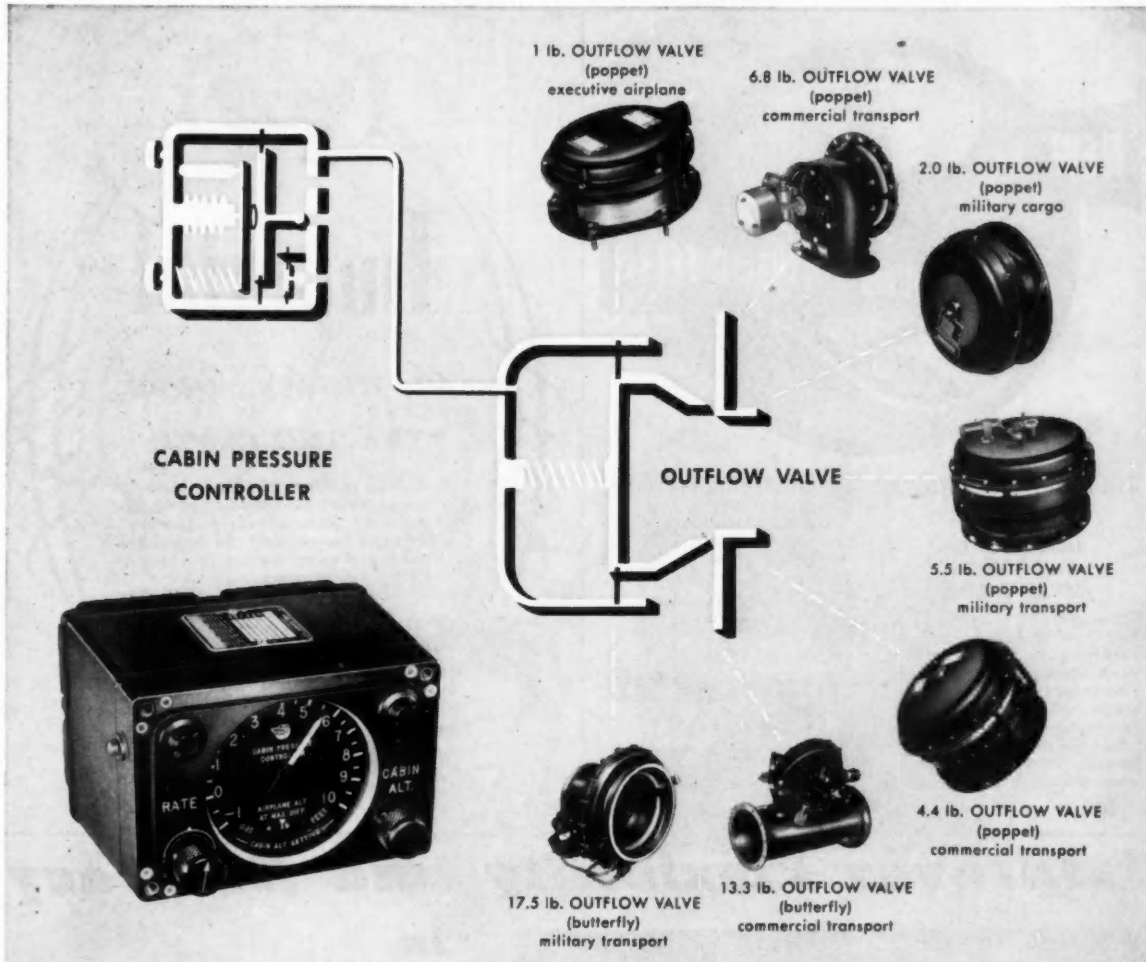

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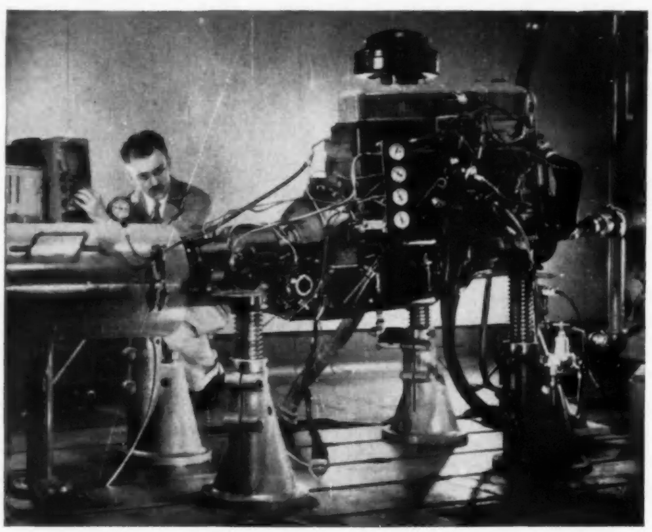

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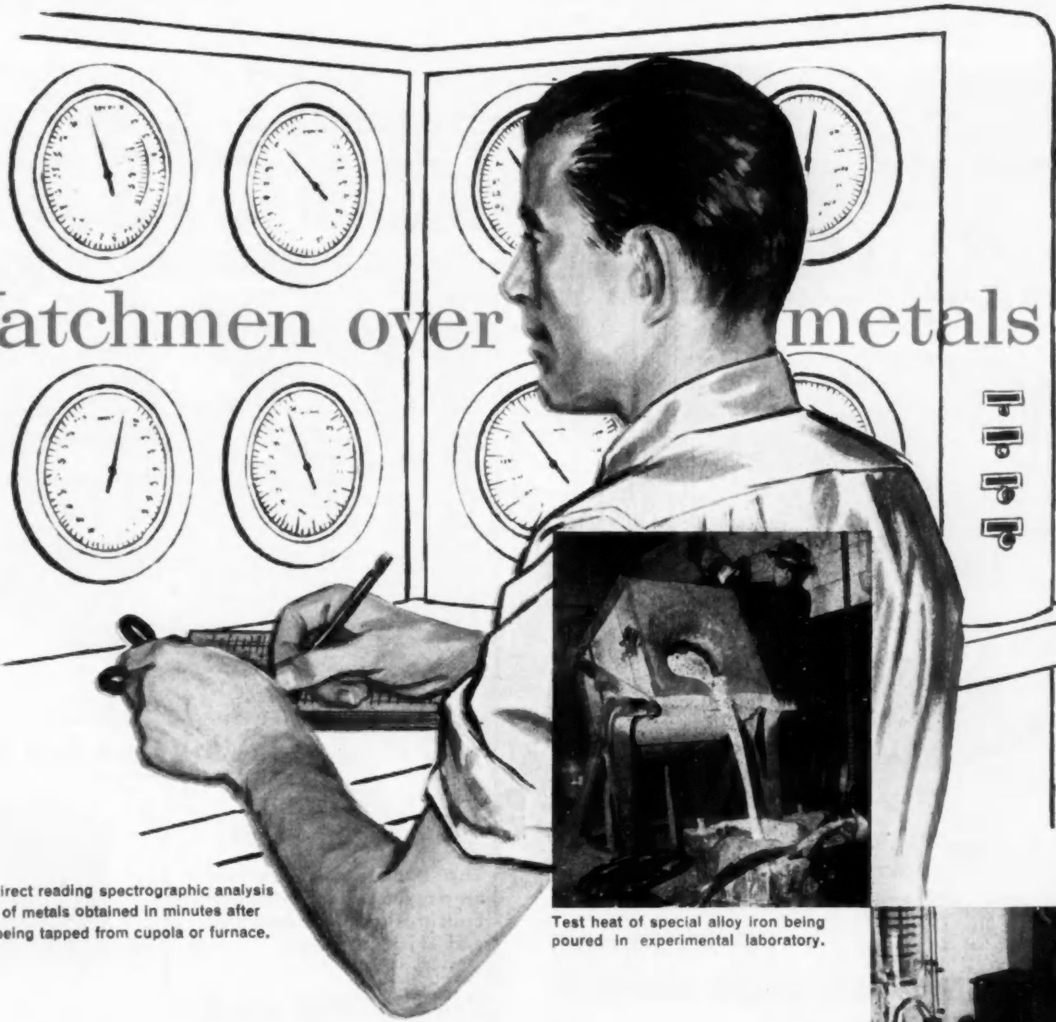

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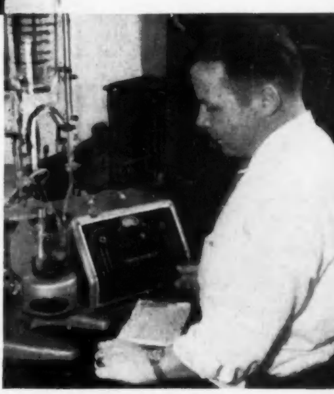

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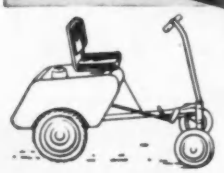

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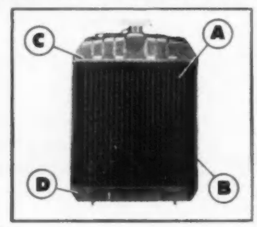

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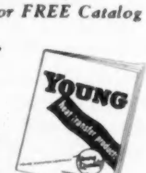

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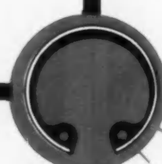
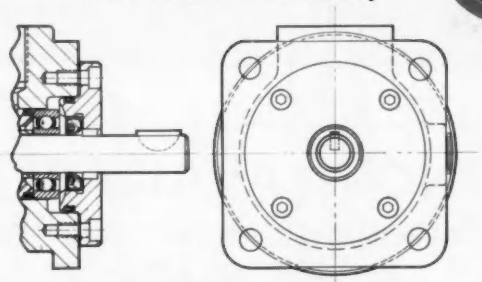


Shaft Seal Subassembly



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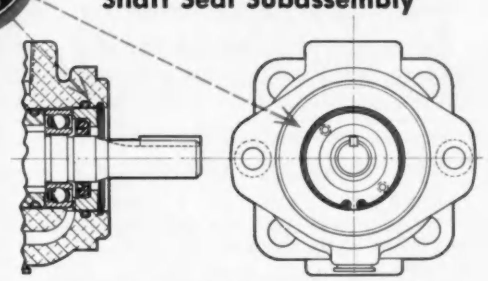
Shaft Seal Subassembly



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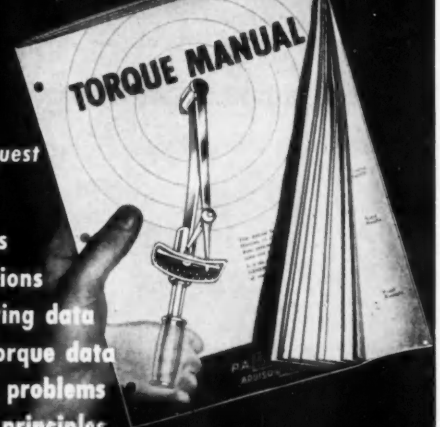

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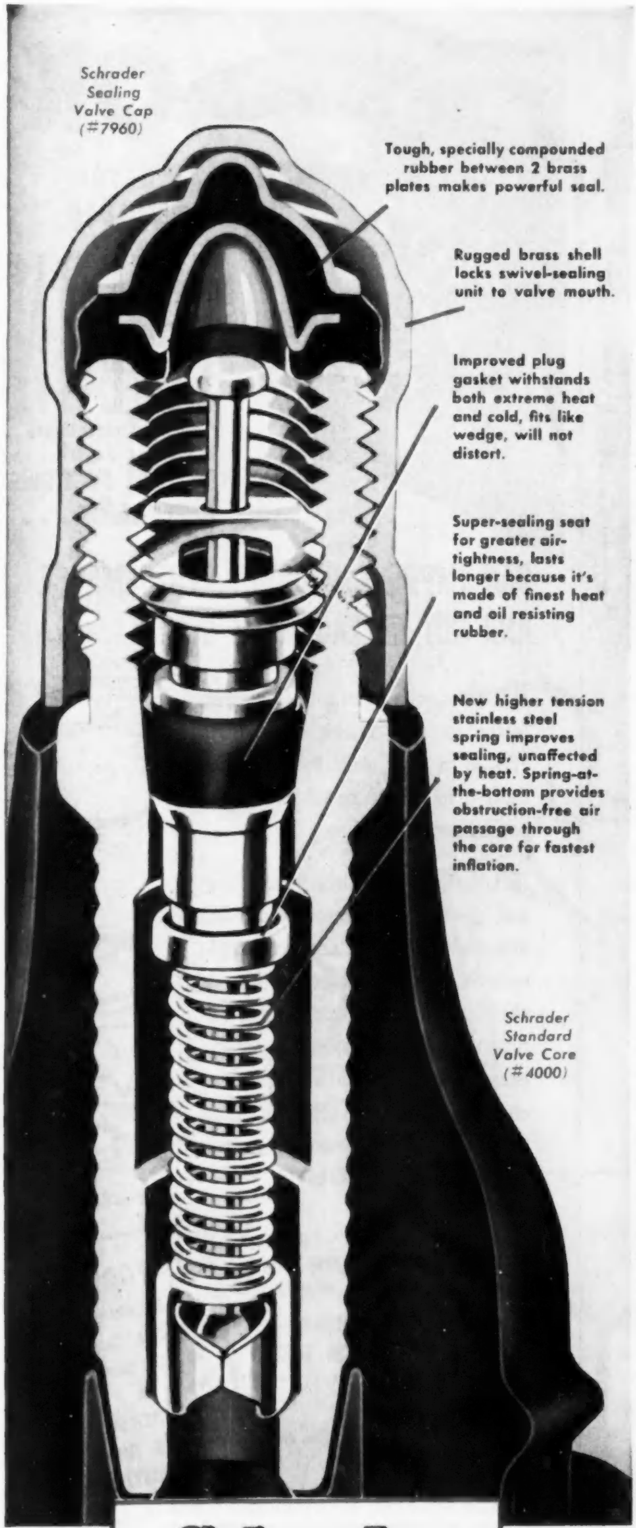

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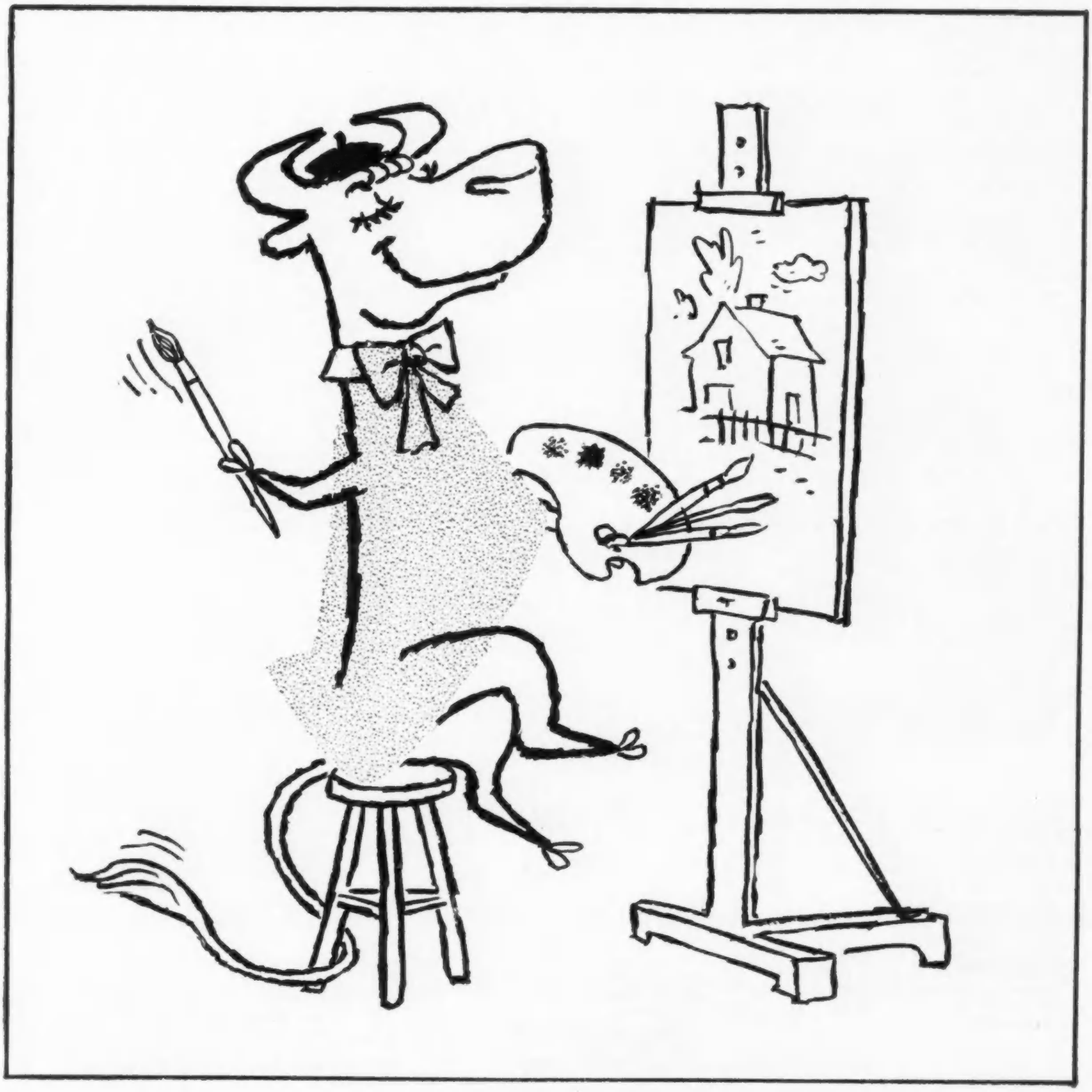

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Seldom has color been more important to your selling than it is right now. Never have you had better colors to work with than you get with genuine upholstery leather! Perfect matching, when the designer wants it—perfect harmony at any time. Yet these colors—all of them—are outstandingly practical in leather, because mild soap and water will swish off any kind of stain. Your customers want style, but they want performance, too. They get both, in genuine leather!

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NOW! FOR THE FIRST TIME
DIRECT WRITING CONVENIENCE WITH PHOTOGRAPHIC ADVANTAGES!

Introducing Century ELECTROGRAPH MODEL 420

ELECTROPHOTOGRAPHIC
RECORDING
OSCILLOGRAPH

You Asked For This!

ONLY THE REVOLUTIONARY CENTURY ELECTROGRAPH OFFERS THESE FEATURES

- ***Permanent instantaneous oscillograms***
- ***Eliminates need for messy liquid chemicals***
- ***No darkroom required***
- ***Automatic continuous dry processing***
- ***View oscillogram while recording***
- ***Utilizes sensitive light-beam galvanometers***
- ***Up to 24 traces on eight inch paper***
- ***Traces can overlap***
- ***Precision timing lines***
- ***Low power consumption***

Century's engineers are the first to accomplish the long dreamed-for wedding of photographic recording and completely automatic dry processing to eliminate the need for costly darkroom facilities and liquid developing, rinsing and fixing.

The greatest advancement in the technique of multi-channel oscillograph recording in over 20 years, the CENTURY ELECTROGRAPH is essentially a direct-writing recording oscillograph utilizing the RADICALLY new technique of Electrophotography combined with light-beam galvanometers.

NOW investigate CENTURY ELECTROGRAPH—the most modern approach to simplified oscillographic recording — when planning your instrumentation program whether for research, engineering, test, quality control, process control, or any other analog recording requirement.

COSTS NO MORE THAN OLD-FASHIONED METHODS

Century

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FOR *EXTRA* SAFETY . . .

MEET THE NEW ICC REGULATIONS WITH MIDLAND EQUIPMENT!

Dash hand valve is automatic and manual, functioning as a part of Midland's breakaway system. If emergency line pressure goes below 40 PSI, it automatically applies trailer brakes. They may also be applied and released manually by driver.

Midland's tractor-trailer braking system is designed for the ultimate in braking protection. With this new system (1) tractor protection is AUTOMATIC, so important in split-second emergencies; (2) valves are large-capacity, giving you faster, more positive action; (3) you have a *combination* manual and automatic dash control valve for *instantaneous* application and release of trailer brakes; (4) manual shut-off cocks are eliminated . . . Specify Midland Power Brakes for extra quality performance, more positive protection. Make it Midland, too, when replacing or modernizing the braking system on your present equipment. Your nearest Midland distributor is anxious to serve you. Just give him a call.

THE MIDLAND STEEL PRODUCTS CO.
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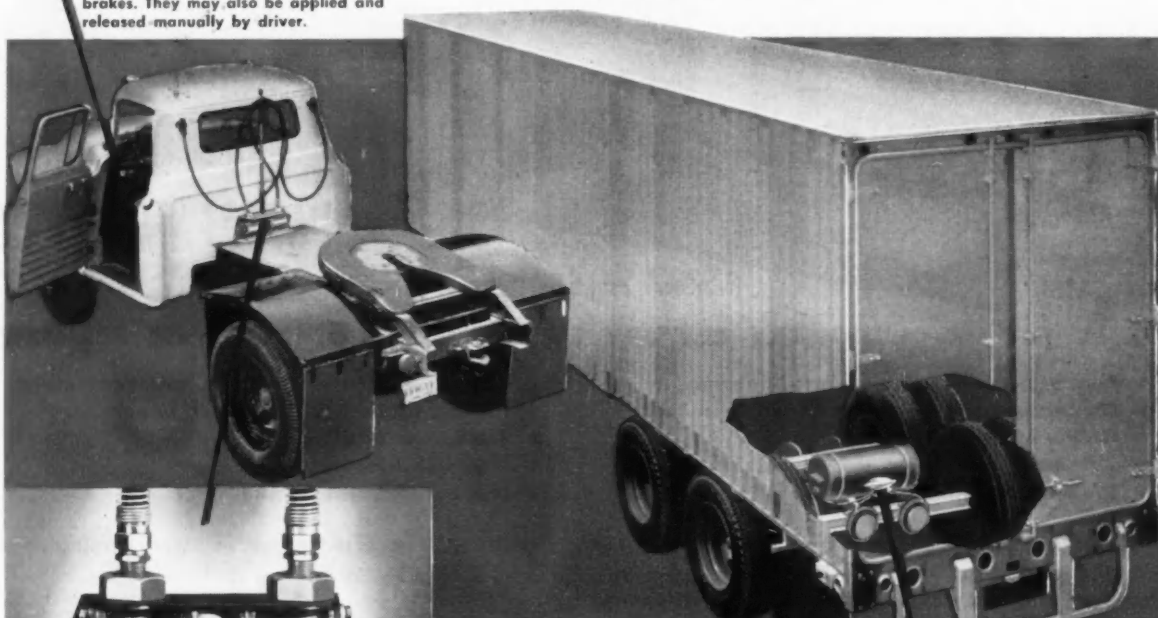
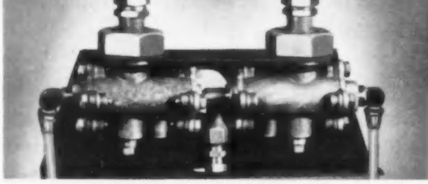
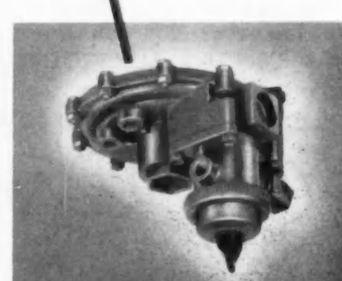




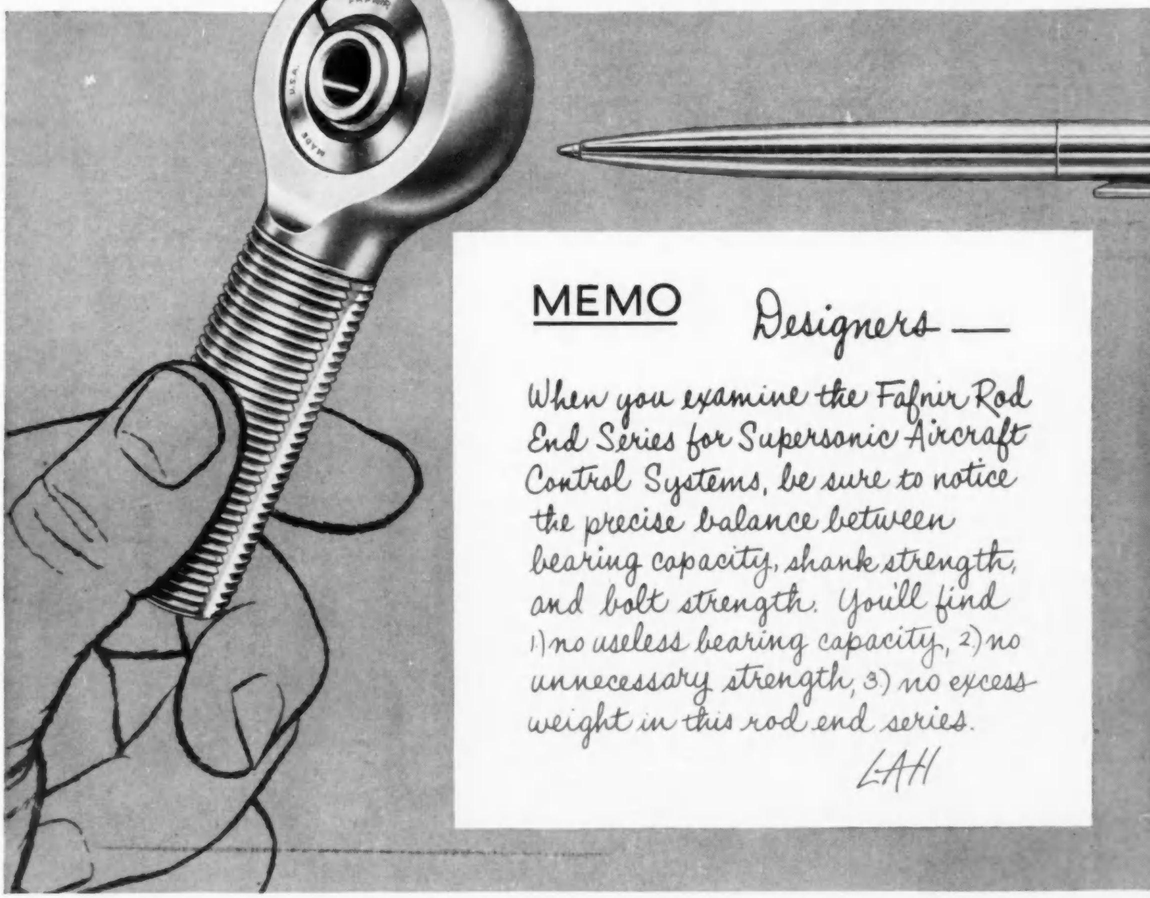
Automatic shut-off valves eliminate hand-operated shut-off cocks and function as part of the Midland breakaway system to retain adequate tractor pressure for breakaway protection.

Midland's new air emergency relay valve meets the "no feed back" requirement. Designed to reduce application and release time. Safeguards against vehicle driveaway without sufficient air in the system.



GO MIDLAND — AND STOP SAFELY!

The only Rod End Series designed with THREE-WAY BALANCE



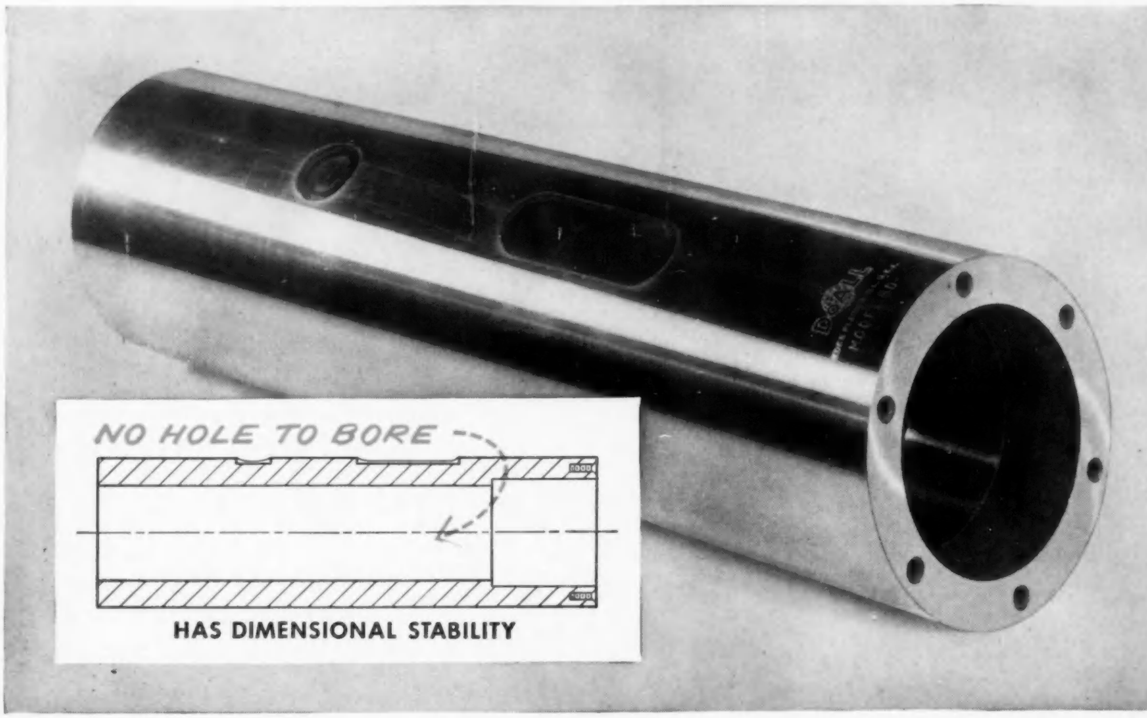
AN OUTSTANDING EXAMPLE OF TEAMWORK

The manufacture of rod ends is nothing new to Fafnir. Nonetheless Fafnir bearing specialists sought the advice and counsel of engineers and designers in the airframe industry when they started to work on their latest series of rod ends. Selection of thread length and the design of keyways, criteria for establishing shank strength, along with other design problems, were subjects of cooperative study. The results — a self-aligning, balanced-design series of rod ends that meets the needs of supersonic aircraft control systems precisely. The ball type is designed for low-torque, sensitive, manually-operated control systems. The roller type is designed for use in heavily-loaded, power-operated control systems.

In addition to balanced-design, this rod end series offers many other features, including . . . inner rings of SAE 52100 steel, through-hardened; outer rings, with carburized races and integral shanks, made of highest grade alloy steel; shanks designed to withstand column action under compression with angularity as high as 9°. Complete details plus dimensions and load-life ratings are available in bulletin 446. Send for a copy. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
AIRCRAFT BEARINGS

FIRST at the turning points in aircraft design



DoALL switches to TIMKEN® seamless steel tubing —cuts spindle housing cost 26%

THE DoALL Company faced a tough problem in reducing production costs of its precision spindle housing, while retaining the required dimensional stability. Timken Company metallurgists came in, worked with DoALL's engineers and recommended a change from the bar stock previsously used to Timken® seamless steel tubing.

Immediate savings resulted. Machining time was cut. With Timken seamless tubing, the hole was already there. No drilling required. Scrap loss reduced. More parts produced per ton of steel. One of the annealing operations required with bar stock was eliminated.

DoALL and Timken Company metallurgists devised stress-relieving operations to insure complete stability in the finished part. By changing to Timken seamless steel tubing, DoALL's production cost per housing was cut 26% and thorough lab tests proved there were no dimensional changes in the finished part.

Timken Company metallurgists will gladly work with you on your hollow cylindrical parts jobs, to help you make important production savings with Timken seamless steel tubing. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING